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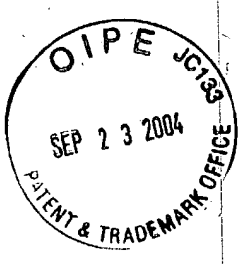
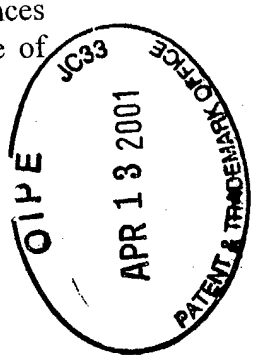


SUBMITTED: Transmittal letter for Information Disclosure Statement (3 pages); Information Disclosure Statement (2 pages); Form PTO-1449 listing 5 references with copies of each reference (1 page); Certificate of Deposit



Applicants:	Stefan Johansson
Title:	SELECTIVE RECEPTION
Serial No.:	09/771,120
Confirm No:	7001
Filing Date:	January 26, 2001
Docket No.:	15292.4
Mailed:	April 2, 2001

PATENT APPLICATION
Docket No: 15292.4

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re application of	Stefan Johansson	
Serial No.:	09/771,120	Art Unit 2661
Confirmation No.:	7001	
Filed:	January 26, 2001	
For:	SELECTIVE RECEPTION	

CERTIFICATE OF DEPOSIT UNDER 37 C.F.R. § 1.8

I hereby certify that the following documents are being deposited with the United States Postal Service as First Class Mail, postage prepaid, in an envelope addressed to: Assistant Commissioner for Patents, Washington, DC 20231, on the 6th day of April 2001.

- Transmittal for Information Disclosure Statement (3 pages)
- Information Disclosure Statement (2 pages)
- Form PTO-1449 listing 5 references (1 page)
- Copies of each listed reference
- Postcard

Respectfully submitted,

DANA L. TANGREN
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PATENT APPLICATION
Docket No: 15292.4

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IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re application of		)
	Stefan Johansson	)
Serial No.:	09/771,120	) Art Unit
Confirmation No.:	7001	) 2661
Filed:	January 26, 2001	)
For:	SELECTIVE RECEPTION	)

TRANSMITTAL FOR INFORMATION DISCLOSURE STATEMENT

Assistant Commissioner for Patents
Washington, DC 20231

Sir:

Transmitted herewith for filing and pursuant to 37 C.F.R. § 1.97 is an Information Disclosure Statement, which includes the following statements, if any, required variously by 37 C.F.R. § 1.98:

___ Statement of relevance of selected cited references not in the English language which are not translated.

___ Statement that selected cited references are substantially cumulative of an enclosed or previously submitted reference.

___ Statement that selected cited references were previously cited by or submitted to the United States Patent and Trademark Office in a prior application which is relied upon for an earlier filing date under 35 U.S.C. § 120.

A. Additional Materials Required Due to Content of Information Disclosure Statement

Transmitted are the following documents in addition to the Information Disclosure Statement as required variously under 37 C.F.R. § 1.98:

X Form PTO-1449 listing five references submitted for consideration.

X Copies of each of the references listed on the Form PTO-1449.

___ English translations of ___ (___) of the references listed on the Form PTO-1449 which are not in the English language.

___ Copies of the following documents from the prosecution of a previous, related application:

___ Form PTO-1449 AND INFORMATION DISCLOSURE STATEMENT; and

___ Form PTO-892

B. Additional Materials Required Due to Timing of Filing of Information Disclosure Statement

The transmitted Information Disclosure Statement is being filed within one (1) of the following four (4) time periods:

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___ Check No. _____ in the amount of $240.00 constituting the submission fee set forth in 37 C.F.R. § 1.17(p).

III. ___ After the mailing of a Notice of Allowance, but before payment of the Issue Fee. Accordingly, in order to secure consideration thereof, each of the following are also enclosed:

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C. Fees

The Commissioner is hereby authorized to charge payment of or any deficiency in the following fees associated with this communication, or to credit any overpayment thereof, to Deposit Account No. 23-3178. A duplicate copy of this letter is enclosed.

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___ The submission fee set forth in 37 C.F.R. § 1.17(p).

___ The petition fee set forth in 37 C.F.R. § 1.17(i)(1).

Dated this 6th day of April 2001.

Respectfully submitted,

DANA L. TANGREN
Attorney for Applicant
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022913

PATENT TRADEMARK OFFICE

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Enclosures
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PATENT APPLICATION
Docket No: 15292.4

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re application of	Stefan Johansson	
Serial No.:	09/771,120	Art Unit 2661
Confirmation No.:	7001	
Filed:	January 26, 2001	
For:	SELECTIVE RECEPTION	

INFORMATION DISCLOSURE STATEMENT
UNDER 37 C.F.R. § 1.97

Assistant Commissioner for Patents
Washington, DC 20231

Sir:

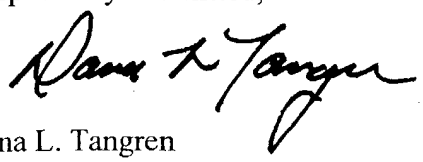
Please find, pursuant to 37 C.F.R. § 1.98(a)(1), the enclosed Form PTO-1449 which contains a list of all patents, publications, or other items that have come to the attention of one or more of the individuals designated in 37 C.F.R. § 1.56(c). While no representation is made that these references may be "prior art" within the meaning of that term under 35 U.S.C. §§ 102 or 103, the enclosed listed references are disclosed so as to fully comply with the duty of disclosure set forth in 37 C.F.R. § 1.56.

Moreover, while no representation is made that a specific search of office files or patent office records has been conducted or that no better art exists, the undersigned attorney of record believes that the enclosed art is the closest to the claimed invention (taken in its entirety) of which the undersigned is presently aware, and no art which is closer to the claimed invention (taken in its entirety) has been knowingly withheld.

In accordance with 37 C.F.R. §§ 1.97 and 1.98, a copy of each of the listed references or relevant portion thereof is also enclosed.

Dated this 6th day of April 2001.

Respectfully submitted,



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Form PTO-1449
Applicant: Stefan Johansson
Serial No.: 09/771,120
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For: SELECTIVE RECEPTION

Confirmation No.: 7001
Att'y Docket No.: 15292.4
Group: 2661

INFORMATION DISCLOSURE CITATIONS MADE BY APPLICANT

Foreign Patent Documents

Examiner Initial*	Document Number	Publication Date	Country or Patent Office
_____ 1	WO 97/08906	03/06/97	PCT
_____ 2	WO 97/26764	07/24/97	PCT
_____ 3	WO 99/05828	02/04/99	PCT
_____ 4	WO 99/17579	04/08/99	PCT
_____ 5	WO 99/43143	08/26/99	PCT

References Cited by Applicants

While the filing of Information Disclosure Statements is voluntary, the procedure is governed by the guidelines of Section 609 of the Manual of Patent Examining Procedure and 37 C.F.R. §§ 1.97 and 1.98. To be considered a proper Information Disclosure Statement, Form PTO-1449 shall be accompanied by a copy of each listed patent or publication or other item of information and a translation of the pertinent portions of foreign documents (if an existing translation is readily available to the applicant), an explanation of relevance of each reference not in the English language, and should be submitted in a timely manner as set out in MPEP Sec. 609.

Examiners will consider all citations submitted in conformance with 37 C.F.R. § 1.98 and MPEP Sec. 609 and place their initials adjacent the citations in the spaces provided on this form. Examiners will also initial citations not in conformance with the guidelines which may have been considered. A reference may be considered by the Examiner for any reason whether or not the citation is in full conformance with the guidelines. A line will be drawn through a citation if it is not in conformance with the guidelines AND has not been considered. A copy of the submitted form, as reviewed by the Examiner, will be returned to the applicant with the next communication. The original of the form will be entered into the application file.

Each citation initialed by the Examiner will be printed on the issued patent in the same manner as references cited by the Examiner on Form PTO-892.

The reference designations "A1," "A2," etc. (referring to Applicant's reference 1, Applicant's reference 2, etc.) will be used by the Examiner in the same manner as Examiner's reference designations "A," "B," "C," etc. on Office Action Form PTO-1142.

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INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification 6 : H04Q 7/22, 7/32, H04L 12/58

A1

(11) International Publication Number: **WO 97/08906**

(43) International Publication Date: 6 March 1997 (06.03.97)

(21) International Application Number: PCT/SE96/01077

(22) International Filing Date: 30 August 1996 (30.08.96)

(30) Priority Data:
9502995-5 30 August 1995 (30.08.95) SE

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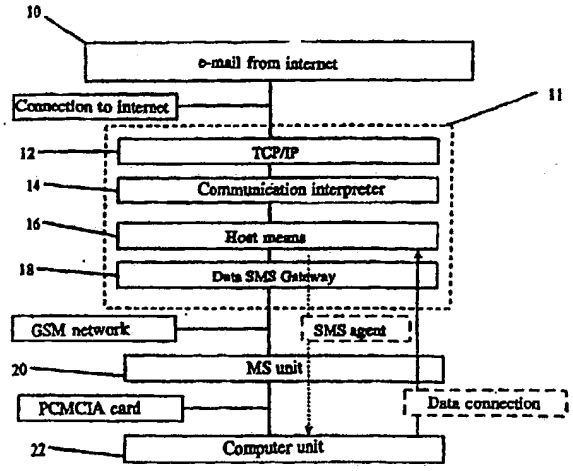
(81) Designated States: AL, AM, AT, AU, AZ, BB, BG, BR, BY, CA, CH, CN, CZ, DE, DK, EE, ES, FI, GB, GE, HU, IL, IS, JP, KE, KG, KP, KR, KZ, LK, LR, LS, LT, LU, LV, MD, MG, MK, MN, MW, MX, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, TJ, TM, TR, TT, UA, UG, US, UZ, VN, ARIPO patent (KE, LS, MW, SD, SZ, UG), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, ML, MR, NE, SN, TD, TG).

Published
With international search report.
In English translation (filed in Swedish).

(54) Title: SYSTEM AND HOST ARRANGEMENT FOR TRANSMISSION OF ELECTRONIC MAIL



(57) Abstract

The present invention relates to a system and to a host arrangement (11) for transmitting e-mail over a mobile telephone network with the aid of short text message routing means (SMS-C) existing in the network. According to the invention, e-mail is coupled with a modified short text message containing an agent which, through the medium of control characters, is recognized in an address mobile station (20). Software in a computer (22) decodes the agent and initiates the transmission of e-mail from the host arrangement (11), wherein the mail is loaded into the computer (22) from the mobile station (20), via a PCMCIA connection. The invention also relates to a method for automatically registering network addresses in a system according to the aforegoing, there being used a modified SMS message for identification of the installing subscriber.

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SYSTEM AND HOST ARRANGEMENT FOR TRANSMISSION OF ELECTRONIC MAIL

FIELD OF THE INVENTION

The present invention relates to a system and to an arrangement for transmitting electronic mail over mobile telephone networks with the aid of means existing in the network for routing short text messages, such as SMS-messages. The invention also relates to a method of registering subscribers with electronic mail addresses. More particularly, the invention relates to an electronic data transmission system wherein the data is linked with a modified short text message. The invention also embodies a local free-standing host arrangement which can be connected to existing mobile telephone networks, subscriber exchanges or switching centres, communication networks, and so on.

DESCRIPTION OF THE BACKGROUND ART

Existing mobile telephone networks include operator services in the form of short message services (SMS) in GSM (Global System for Mobile Communication), i.e. messages (about 160 data characters) which are received and converted to text form in the display of a mobile station (MS). MS displays are only able to accommodate a limited number of characters at a time, and it would therefore be clumsy to receive longer messages via the MS unit, such as text masses included in electric mail possibly together with files (text, graphics, etc.).

In order to route the SMS message through the mobile telephone network to the correct receiver in a mobile telephone network via an address, the network has a GMSC function (Gateway Mobile Switching Centre function) in one or more mobile services switching centres (MSC) in the mobile telephone network. GMSC functions administer telephone

traffic for communication systems external of the mobile telephone network. The SMS messages to be routed through the network are linked via the GMSC function to an SMS-centre (SMS-C) which is responsible for routing the message to the correct MS unit, wherewith the MS unit indicates the receipt of SMS messages.

Further GSM, ADC (American Digital Cellular), JDC (Japan Digital Cellular), or other wireless telephone systems and Internet constitute two of the most rapidly developing commercial telecommunications systems. However, it is difficult to communicate between the respective commercial systems. Calling the internet via the GSM system is not particularly practical configuration; air time is expensive, connection waiting times and calls are of long duration, etc. Furthermore, existing internet connections are not optimized for use by mobile telephones.

It will be evident from the aforegoing that there is a need to be able to send longer text messages than SMS messages to mobile telephone subscribers, and the need for simplified solutions for access between mutually different communications systems.

SUMMARY OF THE INVENTION

The present invention relates to a system and to an arrangement for transmitting a practically unlimited volume of text and picture data to a subscriber of a mobile telephone network through the medium of an MS unit.

The invention relates to a system for transmitting electronic mail over a mobile telephone network with the aid of short text message routing means existing in the network. The system includes:

- means for routing electronic mail from a network which manages such mail and has an interface connected towards

- means for receiving and storing electronic mail which is allocated a short text message with agent connected to
- means for connecting data with a mobile telephone switching centre and short text message routing means existing in the mobile telephone network;
- means in a mobile station for receiving the short text messages from said existing routing means and storing said messages in the mobile station;
- means for establishing a connection between the mobile station and a computer means for transmitting data between the mobile station and the computer, and vice versa; and
- software containing agent decoding means and instructions for initiating the transmission of electronic mail via said means for establishing a data connection setup.

In one embodiment, the software containing means is installed in a computer.

In another embodiment, the software containing means is installed in a mobile station.

Electronic mail sent from the computer to the host arrangement is allocated a short text message provided with control characters and agent for distribution to another mobile telephone subscriber. The agent includes encryption files, host number, job identity and job pass code. The encryption field can be generated randomly for each short text message.

The invention also relates to a selectively positionable host arrangement for receiving and storing electronic mail and for transmitting electronic mail with the use of the means that exist in the mobile telephone network for routing short text messages to mobile stations, wherein the arrangement includes:

- means for receiving and storing electronic mail which is allocated a short text message with agent, and having an interface towards electronic mail routing means; and

- means for establishing a data connection via local means for telecommunication with a mobile telephone switching centre, and means existing in the mobile telephone network for routing short text messages with said agent to a mobile station.

The present invention also relates to a method for registering subscribers with an electronic mail address in systems for transmitting electronic mail over a mobile telephone network with the aid of network existing short text message routing means, wherein electronic mail is allocated a short text message that includes an agent which is used to initiate transmission of electronic mail between a communications network and mobile stations connected to transmission software, and vice versa, wherein

- the software is installed in a computer;
- wherein installed software automatically calls an electronic mail receiving and storing means upon initiation of the software;
- wherein installed communications software commands a user (client) to insert desired electronic mail addresses, personal information, mobile station subscriber number, software initiation password, and information relating to user computer configuration; and
- in that electronic mail receiving and storing means sends an activation code to the computer with installed software through the medium of a short text message, said code being used to activate software for receiving and transmitting electronic mail with agent.

The activation code can be inserted manually in the software in order to terminate the installation.

Alternatively, activation can be effected automatically with the use of a modem that supports handling of short text messages.

In one embodiment, the software can be taken to the computer from the network, for instance from a home side in the network.

It is beneficial, and at times even desirable, to effect a handshake between the host arrangement and the computer with a PIN code as soon as possible upon receipt of the message.

BRIEF DESCRIPTION OF THE DRAWINGS

The invention will now be described in more detail with reference to preferred embodiments thereof and also with reference to the accompanying drawings, in which

Fig. 1 is a flow chart which illustrates routing of electric mail via SMS in accordance with the present invention;

Fig. 2 is a block schematic illustrating an inventive system;

Fig. 3 is a block schematic illustrating an inventive host arrangement;

Fig. 4 illustrates diagrammatically the transmission of e-mail via SMS with agent in a system constructed in accordance with the invention;

Fig. 5 illustrates diagrammatically automatic registering of an e-mail address for access to Internet in accordance with one embodiment of the invention; and

Fig. 6 illustrates diagrammatically the manner in which a user of the inventive system can download information from Internet.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

The present invention is described in the following with reference to embodiments thereof and also with reference to the GSM system and its function with respect to short text messages (SMS), although it will be understood that the invention is not restricted to any specific wireless telephone system such as GSM and its function for short text messages (SMS), and that other telecommunications systems that include the transmission of short text messages or are expected to include this function in the future, such as the standards ADC, JDC, etc., can be used in conjunction with the invention.

Data packet transmission networks can also be notified in one or more packets with an agent in accordance with the invention. The agent is described in more detail below.

The term e-mail as used with reference to the present invention shall be understood in its widest meaning to include digital communication of e-mail files, facsimiles, pagers, etc.

Fig. 1 is a flowchart which presents an overview of how a mobile telephone subscriber obtains access to information from an external communications network, e.g. Internet, separate from the mobile telephone network according to the present invention.

In block 10, the subscriber receives an e-mail from Internet, said subscriber having the e-mail address åbon.nent@teleoperatör.mail.se. In this case, the Teleoperator is a company which provides mobile telephone services and which has a host arrangement (11) connected to the mobile telephone network according to the invention. The host arrangement 11 is comprised of interfaces and means 12, 14, 16 and 18. The Internet communication is routed through an Operator which supplies lines or trunks for telephone and/or data communica-

tion, for instance Transpac®, in Fig. 1 via a 64-kbit line to the host arrangement 11.

The interface 12 includes a communication protocol, e.g. TCP/IP (Transmission Control Protocol/Internet Protocol), for transmission between, e.g., Transpac® and the host arrangement 11. The interface 12 is also connected to a communications interpreter, e.g. WinSocket® 14, which translates the data received to a format suitable for storage in the host means 16 of the host arrangement 11. The means 18 is a Data-SMS Gateway, i.e. a means having the function of connecting itself with the mobile telephone network via a modem or directly digital via routes, and is connected to SMS-C. In the present embodiments, administration of the host arrangement 11 is effected by means of Windows® applications, for instance.

There now follows an example of communication established via Internet towards the mobile station (MS) in accordance with invention, with continued reference to Fig. 1.

The invention uses a version of an SMS message that has been modified in accordance with the invention insofar that the SMS message has been provided with an SMS agent having a data field. An agent encryption code can be generated randomly for each SMS message through the medium of a random generator. The code may include selected character positions in the SMS message in which a function that is included in communications software 46 in a computer 22 for decoding and initiating transfer of e-mail can find relevant information. The SMS message preferably retains its present configuration with about 160 character positions.

E-mail 10 from Internet is stored in the host unit 16 and is coupled with an SMS message. Storage is effected with a file address, e.g. emailout.db, wherewith the host unit 16 initiates the SMS message coupled with emailout.db to the Gateway

means 18 with the following text message for instance, followed by control characters or code characters, wherein the character string within the citation marks is shown in the MS display window of the address subscriber "E-mail:,Abon.doc 376 kbyte, avs xxx.yyy@sendit transmission time about 1.5 min. Activate PC and start abcdmail" 45445564-67454547704656323#¤/(#))#!/"))))¤###¤. (150 characters). The characters following the last citation sign constitute the SMS agent. The SMS message may optionally be given a prefix which indicates that the message is modified message, so that a PC 22, computer or an MS unit with sufficient memory and data processing capacity is able to process the message as a modified message.

Because a subscriber may be known under several addresses in e-mail, a subscriber in the host arrangement 11 receives a primary address and possibly at least one alias address. The SMS message is decoded so as to obtain access to emailout.db with the aid of the SMS agent, which discloses the correct access code to emailout.db for establishing a data connection with the host arrangement 11 given in the agent, so that e-mail can be transmitted via the MS unit 20 and preferably a PCMCIA connection (Personal Computer Memory Card International Association; standard) to a PC 22 for instance, or some other computer. The transmission can also be effected through some other known transmission between the I/O ports of an MS unit for a computer, such as wireless transmissions with infrared light, radio waves, ultrasound, laser light, other electromagnetic radiation, and so on.

When the SMS message command "Activate PC" is followed by connecting a PCMCIA card between the MS unit and the PC unit or some other computer, the SMS agent is decoded by a client function or communications software in the PC unit, therewith providing information as to from where emailout.db can be collected. In the future, when a mobile station can be

expected to consist of a computer hybrid, the SMS agent decoding functions may be included in the MS unit.

According to the invention, the term agent will preferably be interpreted as a data field in an SMS message modified in accordance with the invention, which enables initiation and transmission of e-mail by decoding the data fields. The agent contains information which clarifies the place in the SMS message from which the communications software collects necessary information.

Gateway 18 connects itself to the mobile telephone network and sends the SMS message via the function SMS centre (SMS-C) existing in the network and monitors the transmission. The SMS message is read by the MS unit 20 subsequent to the message being routed to the correct MS unit in the network via SMS-C. When the PCMCIA card is connected between the PC unit 22 and the MS unit 20, there is activated a sub-program of a Gateway communications software in PC unit 22 or the computer, this sub-program dealing with functions associated with data setup and collection of e-mail, for instance designated "Collect e-mail", therewith displaying, for instance, the following text on the display screen of the PC unit 22, "An e-mail, Abon.doc 376 kbyte, avs xxx.yyy@sendit, transmission time about 2 min."

There are given in the following some examples of how the subscriber is able to activate a data transmission initiating string in the SMS agent with the aid of defined function buttons in the PC unit 22:

* "Collect e-mail now" - Activate a GSM data coupling to the host means
* "Collect e-mail later" - Store agent as C:\MS unit\LATER\ subs.doc?"Yes" or "No" - and so on.

* "Collect e-mail later" - Show all stored SMS agents - etc. (this function replaces the above function when the sub-program is started-up without the SMS agent read in).
* "Forward e-mail" - "Save copy" - "to whom" - activate address book, pager, facsimile - etc.
* "Delete e-mail" - "are you sure..." - etc.
* "Any e-mail to pick up?" - Send an SMS query to the host means 16 asking whether there is any e-mail to be collected.

These procedures are only given by way of example and are intended to demonstrate the principle of usable functions of defined function buttons. The hyphens indicate functions and queries that are initiated when pressing buttons.

When the subscriber indicates the e-mail read-in function key, a data connection is automatically obtained with the use of information contained in the SMS agent. E-mail is read-in and stored and is shown possibly in the PC unit 22. Upon termination of the session, the Gateway communications program in the PC unit adjusts to read-in further SMS agents.

The broken line arrow in Fig. 1 indicates a GSM data connection to the host arrangement 11 for querying in accordance with the above function button. The full line arrow in Fig. 1 denotes a data connection for collecting e-mail stored in the host means 16.

In one embodiment, the modified SMS message including the agent is configured with the following data fields:

Text field

[Prefix] - shows that the SMS message includes an agent, e.g. /e-mail/.

[Free text] - optional text, e.g. "You have a new e-mail..."

Agent field

[Encryption] - agent field encryption code.
[Host No.] - shows on which subscriber number e-mail is found.
[JobId] - identifies the job to be collected in the data SMS Gateway means.
[PWD] - job password.

The communications software in the PC unit 22, or in some other computer, obtains via the encryption field information necessary in accordance with the aforegoing to read the SMS message and, in this way, obtain access to emailout.db in the present example.

Fig. 2 is a block diagram illustrating an inventive system. The Figure illustrates the host arrangement 11 in the system connected to Internet 10. The Gateway means is connected to the mobile services switching centre, MSC, in the GSM mobile telephone system (dotted in the Figure) via modem 24. The mobile services switching centre, MSC, establishes communication between the SMS centre in the mobile telephone system for routing SMS messages and communications software 46 and applications software 49, i.e. e-mail coupled with a modified SMS message. The agent is sent from the host arrangement 11 to the SMS centre, and vice versa, via an X.25 communication, for instance.

Fig. 3 illustrates the host arrangement 11 as a unit in block form, wherein the block represents communications protocol 12 TCP/IP connected to Internet for instance, communications interpreter WinSocket® for instance, and the Data SMS Gateway means 18 which is connected to modem 24 as a modem bank or modem pool for instance, and to the router SMS-C. The host arrangement 11 of Fig. 3 is locally free-standing and can therefore be placed in accordance with customer specifications via a modem or telephone exchange for connection with a mobile telephone network.

In one embodiment, the host means 16 may include the following databases:

* CUSTOMER.DB	customer database
* SUBSCRIBER.DB	subscriber database
* EMAILIN.DB	accumulated databases for incoming e-mail
* EMAILOUT.DB	accumulated databases for outgoing e-mail

The database EMAILOUT.DB thus provides the function of transmitting e-mail from the computer 22 to the host arrangement 11 for distribution of e-mail with allocated SMS with agent to other e-mail addresses in mobile telephone systems, by virtue of the host arrangement allocating control characters and agents to e-mail with SMS.

Fig. 4 summarizes and illustrates schematically the transmission of e-mail via an SMS with agent in an inventive system. The mobile telephone system is not marked in Fig. 4, but is understood for illustration purposes as being transparent to information transmissions in accordance with the invention. The arrows in Figs. 4-6 indicate communication between included units.

E-mail that arrives via Internet 10 is converted to receiver destination or receiver address, sender address, appropriate headings, text body and to optionally enclosed files stored in a database 42 in the host arrangement 11 according to the invention, which in the illustrated case has the form of a server 11 designated IGSA Server (Internet GSM Smart Access Server).

An arrived e-mail creates an SMS 50 which is sent to the MS unit 20 of the e-mail addressee. The SMS message is comprised of the following information:

a. An application prefix, e.g. "/e-mail:" 44, wherein the prefix denotes that SMS is an e-mail agent containing a control code for the applications software 49 that a communications software 46 shall recite for access to transmitted e-mail found in a computer 22 connected to an MS unit or to a resident in the MS unit 20.

b. E-mail notification 45 including text to the receiver containing information, such as:
- Type of errand.
- Sender.
- Number of files and their types, e.g. text of graphics, etc.
- Transmission time in a GSM system.
- Size of e-mail, e.g. in bytes.

c. Agent part 48 with information for the communications software 46 and, in certain cases, for the applications software 49, such as:
- A field "Job_id" 41, which gives a work notation for e-mail stored in the server 11.
- A field "Code" 43 which gives a password for obtaining the access-right to download an intended "Job_id" in, e.g., a database connected to communications software 46.
- A field "DSG address (Data SMS Gateway Address)" containing the address and/or telephone number of the server 11 in which intended e-mail has been stored.

SMS 50 is stored in an MS unit, often a cellular telephone, where communications software 46 can read the notified information 45. The receiver is able to read all SMS 50 stored in the MS unit 20, by connecting the MS 20 to a computer 22 having activated communications software 46, and transfer the SMS 50 with the correct prefix to intended applications software 49, for instance the applications software denoted by the prefix "/e-mail:". Thus, different

versions of the applications software 49 or other functions can be denoted with other appropriate prefixes. Thus, an unlimited number of applications software 49 can be connected to a communications software 46.

According to the aforegoing, the correct applications software 49 is activated by the communications software 46 through the medium of the prefix, and notification information 45 is shown in the computer unit 22 together with specific possible commands, such as the functions:

- "Get Now"
- "Get Later"
- "Delete Mail"

Etc.

For instance, when the "Get now" function is activated, the communications software 46 reads the agent-part 48 of SMS and executes the following procedures:

1. Calls the number in the "DSG address" 47 (start of a session).

2. Subsequent to having established a call setup transfers "Job_id" 41 and "Code" 43 to the server 11, which verifies the information and when finding agreement commences the transmission of data in the same session.

3. Releases the transmitting part of the session when transmission is terminated.

Upon completion of the session, the communications software 46 re-adopts an SMS-read setting and continuously reads the connected MS unit 20 in accordance with new notification agents.

The procedure of downloading data in the applications program 49 can be automated when necessary via the SMS agent, i.e. in the case of certain types of message the command "Get Now" can be initiated automatically by the SMS agent.

With reference to Fig. 5, the present invention also includes an embodiment for automatically registering a client, subscriber, user or customer of the inventive SMS system.

The communications software 46 is installed, e.g., in the harddisk of a computer 22 via downloading from a diskette or alternatively from Internet via, e.g., a www.homeside (world wide web - home side). The communications software 46 installation program and, in some instances, the program for installing applications software 49, identifies the modem used and makes adjustments therefor.

When starting-up newly installed software 46 at the beginning of a session, the software automatically calls the server 11 and feeds-in user data required by the communications software 46, this user data possibly comprising parameters such as desired e-mail address with alternatives 1, 2, 3, etc., personal identification number, subscriber number to MS unit 20, desired password when manually downloading e-mail and starting-up software, and information concerning the configuration of a user computer 22 intended for the user database 52 in which all users are registered.

The commenced data session for automatically registering an e-mail address in the server 11 is maintained while the server 11 checks an e-mail address desired by a user in the user database 52, for instance with respect to whether the chosen address is unique or not.

During an ongoing session, a check is made in a special database designated "Bad name db" 54 as to whether or not the chosen address is suitable. For instance, unsuitability may

have many causes, for example the wrong country code may have been given. Furthermore, many words are reserved for use as command words in the system or unallowed because they give offense, etc.

When the automatic registration of an e-mail address has a positive outcome, there is sent a welcome letter or welcome information which includes the accepted e-mail address, possible alias addresses and advice to the newly registered user. The aforesaid data session is indicated by the full line arrows in Fig. 5, wherein the broken line arrows indicate data transmitted during the session.

The communications software 46 thereafter shows an activation window on the display of computer 22, asking the user to insert an activation code, which is sent from the server 11 via an SMS. In this way, registration according to the aforegoing is confirmed independently of automatic registration, via a modified SMS used for identifying an installing subscriber, which thereafter is the method by which e-mail is sent and received by a user registered in the user database 52.

Manual insertion of the obtained code via the activation window activates the communications software 46 for the possibility of sending and receiving e-mail as before mentioned.

When using a modem which supports SMS handling, as certain GSM modems do, activation takes place fully automatically via the communications software 46, i.e. therewith enabling the procedure using the activation window in accordance with the above to be omitted.

However, it is desirable that when receiving the SMS message, the user acknowledges receipt or handshakes with a PIN code,

so that the memory space created in the server 11 does not wait around in the offing for unauthorized use, so to speak.

In one embodiment of the present invention shown in Fig. 6, it is possible to place queries and search for information in a communications system such as Internet, for instance, via the server 11, which is here designated SMS Quary 56. Alternatively, queries/searches can be asked and/or made by a data connection with the server 11. The server 11 then downloads Internet material relating to the query or search and notifies the user via an SMS in accordance with the SMS procedure using an agent in accordance with the present invention, wherein agent handling in the communications software 46 downloads the requested information from Internet. The prefix for the embodiment according to Fig. 6 is here designated "Quary prefix" 60. In other respects, the SMS Quary includes the agents 41, 43, 47 as earlier. The SMS agent may also include more control codes than the aforesaid control codes 41, 43 and 47.

Available bandwidths, such as the GSM bandwidth of 9.6 baud + compression is used in the event of capacity bottlenecks on Internet with full downloading in the server, which automatically compresses the data, wherein the communications software 46 automatically packs-up downloaded information for presentation via the applications software 49 in the computer unit 22.

Queries/searches can be placed in the communications software 46 and/or in the applications software 49 for downloading Internet www.homepages 58.

Other operator updatings, operator settings of new services for the user (the client), for instance news bulletins via www, weather reports, etc., can be sent via SMS in accordance with the present invention.

Although the present invention has been described with reference to preferred exemplifying embodiments thereof, it will be understood that the invention is not restricted to these embodiments. Further embodiments of the invention will be evident to one skilled in this field from the scope of the following Claims.

CLAIMS

1. A system for sending e-mail over a mobile telephone network with the use of short text message (SMS) routing means (SMS centre) that exist in the mobile telephone network, characterized in that the system includes:

- means for routing e-mail from networks (Internet) that handle such mail with an interface (12, 14) connected to
- means (16) for receiving and storing e-mail which is allocated a short text message (SMS) that includes an agent, connected to
- means for data connection with a mobile telephone switching centre (MSC) and short text message routing means (SMS centre) existing in the mobile telephone network;
- means in a mobile station (20, MS) which receives the short text message from said routing means (SMS-C) existing in said station and storing said messages in the mobile station (20);
- means (PCMCIA card) for connection between the mobile station (20) and a computer (22) for transmission of data between the mobile station (20) and the computer (22), and vice versa; and
- means which include software (46, 49) for decoding the agent and instructions for initiating the transmission of e-mail via said means (18) for data connection.

2. A system according to Claim 1, characterized in that the software containing means (46, 49) is present in the computer (22).

3. A system according to Claim 1, characterized in that the software containing means (46, 49) is present in the mobile station (20).

4. A system according to Claims 1-3, characterized in that e-mail sent from the computer (22) to the host arrangement is allocated a short text message with control characters and

agent for distribution to another mobile telephone subscriber.

5. A system according to Claims 1-4, characterized in that the agent includes fields for encryption, host number, job identity and job pass codes.

6. A system according to Claims 1-5, characterized in that the encryption field is generated randomly for each short text message.

7. A host arrangement (11) for receiving and storing e-mail and for transmitting e-mail with the use of means (SMS centre) present in the mobile telephone network for routing short text messages to mobile stations (MS), characterized in that the arrangement includes

- means (16) for receiving and storing e-mail which has allocated a short text message (SMS) with agent, and having an interface towards e-mail routing means (12, 14); and
- means (18) for data connection via local means for telecommunication with a mobile telephone switching centre and means (SMS centre) present in a mobile telephone network for routing short text messages with said agent to the mobile station (20).

8. A method for registering subscription with an e-mail address in a system for transmitting e-mail over a mobile telephone network with the aid of means (SMS centre) present in the network for routing short text messages, characterized in that e-mail is allocated a short text message (SMS) that includes an agent which is used to initiate transmission of e-mail between network (Internet) and mobile stations (20), connected to software (46) for transmission and vice versa, comprising the steps

- wherein software (46, 49) is installed in a computer (22);

- wherein when starting-up, installed software (46, 49) automatically calls means (11) for receiving and storing e-mail;
- wherein installed software (46, 49) commands a user to enter desired parameters for starting-up software (46, 49) and information relating to the user computer configuration; and
- wherein means (11) for receiving and storing e-mail sends an activation code to the computer (22) with installed software (46, 49) via a short text message (SMS), which is used to activate the software (46, 49) for receiving and transmitting e-mail with agent.

9. A method according to Claim 8, characterized in that the parameters are addresses of the e-mail, personal information, mobile station subscriber number, password, and service level.

10. A method according to Claim 8, characterized in that the activation code is inserted manually into software (46) for terminating the installation.

11. A method according to Claims 8-10, characterized in that activation takes place automatically when using a modem which supports handling of short text messages.

12. A method according to Claims 8-10, characterized in that the software (46, 49) is taken to the computer (22) from a network (Internet).

13. A method according to Claim 8, characterized in that the software (46, 49) is taken from a home side in the network (Internet).

14. A method according to Claims 8-13, characterized in that the short text message is acknowledged essentially immediately upon receipt with a handshake between the e-mail receiving

and storing means (11) and the computer (22) by means of a PIN code.

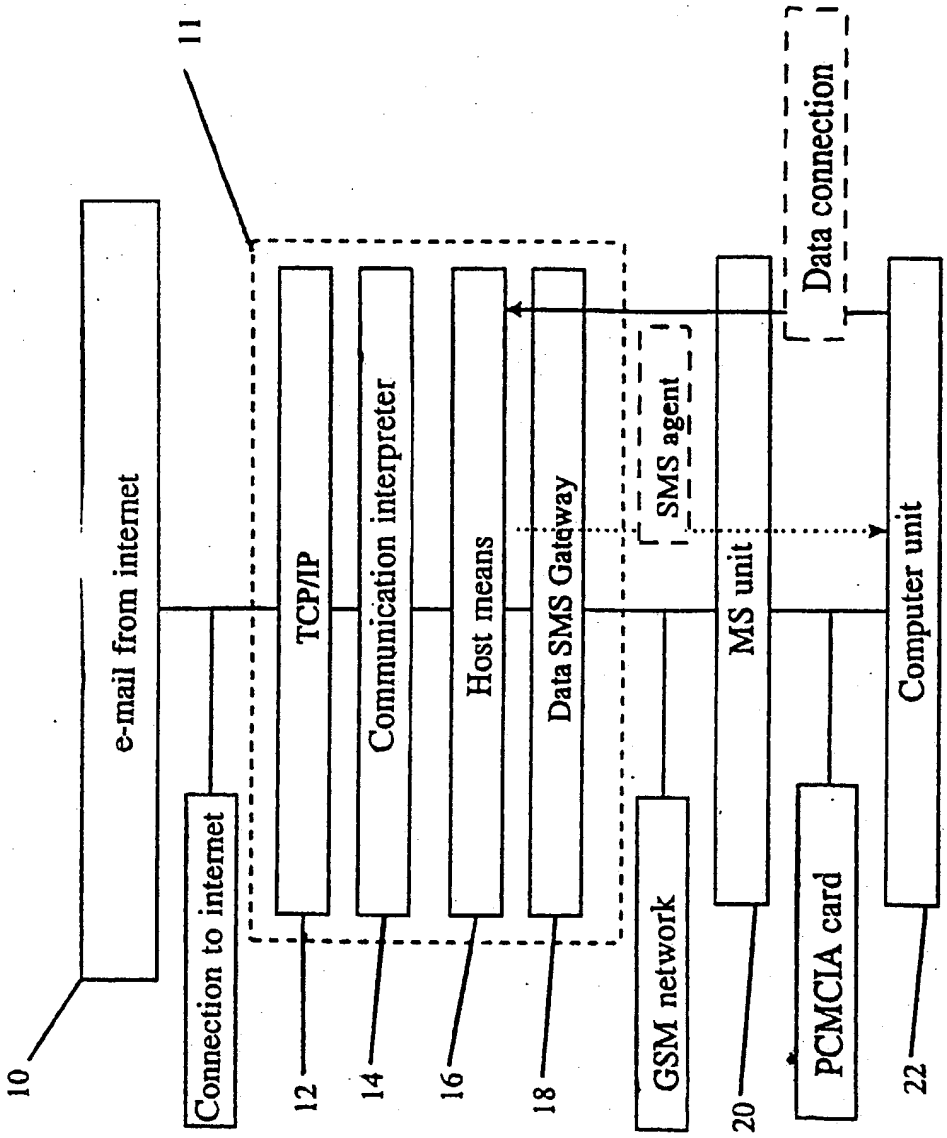
e-mail from internet
Connection to internet
TCP/IP
Communication interpreter
Host means
Data SMS Gatqway
SMS agent
GSM network
MS unit
Data connection
PCMCIA card
Computer unit
10
11
12
14
16
18
20
22

Fig. 1

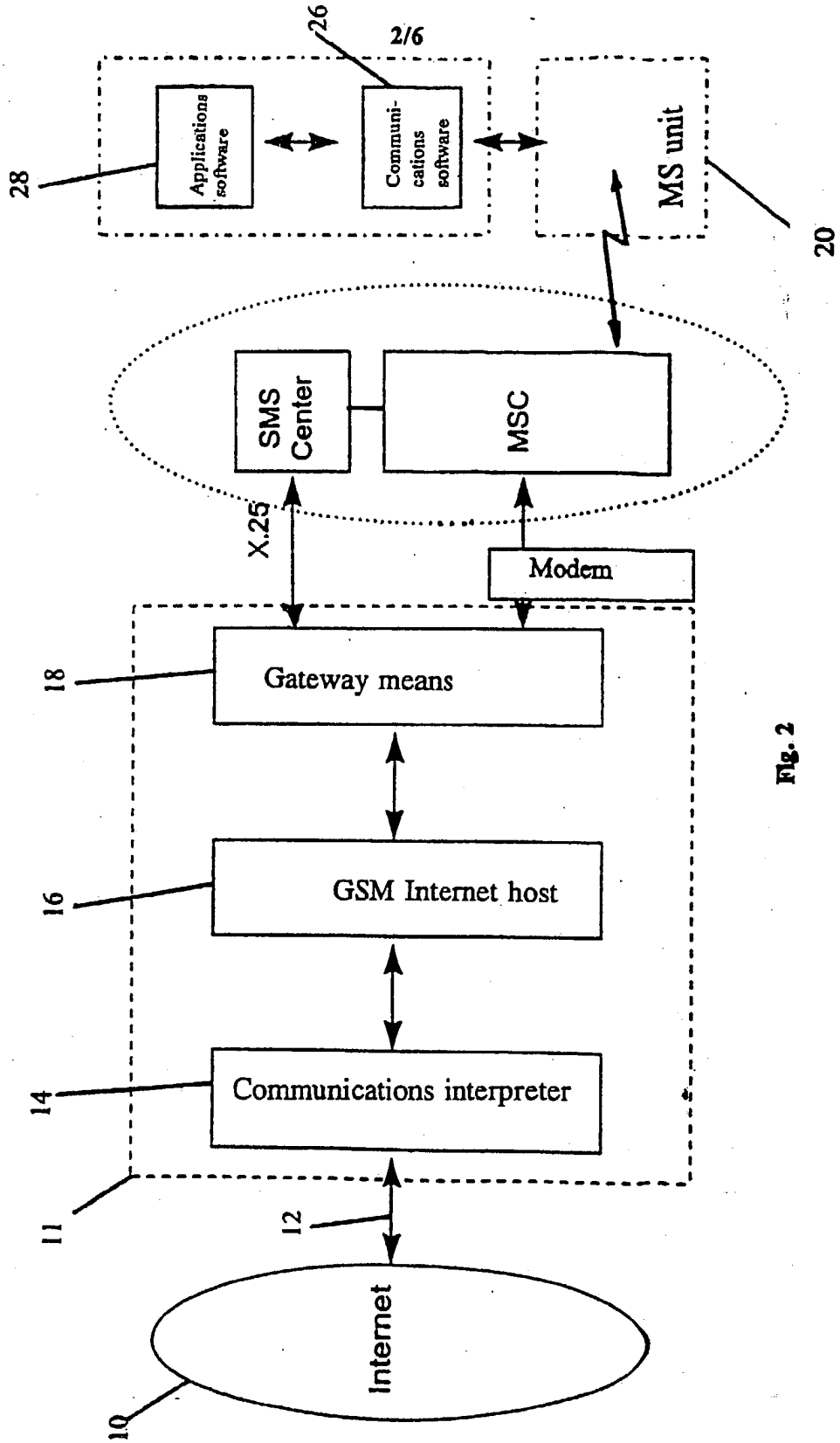
26
28
Applications software
Communi-cations software
MS unit
20
SMS Center
MSC
X.25
Modem
18
Gateway means
16
GSM Internet host
14
Communications interpreter
11
12
Internet
10

Fig. 2

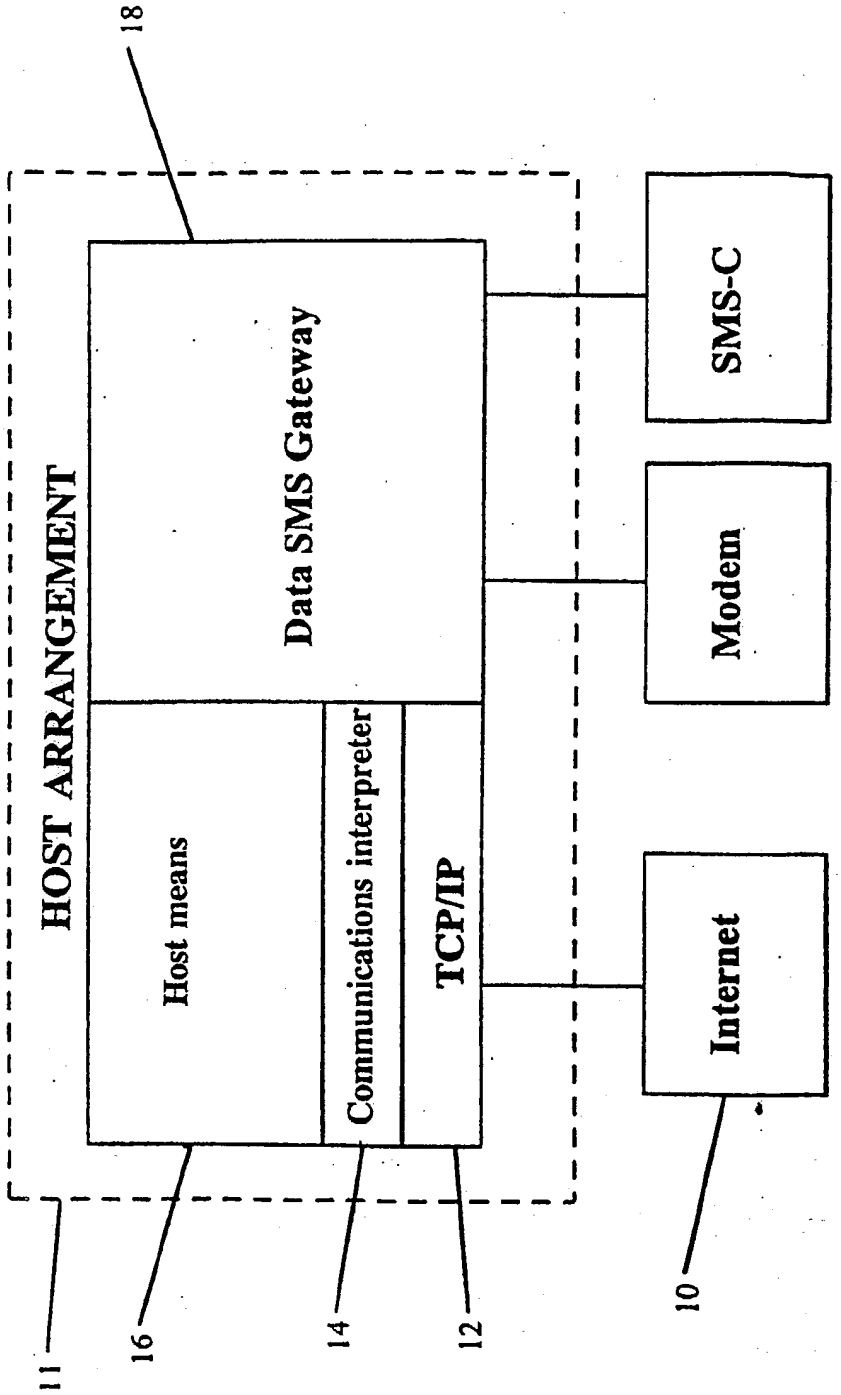
18
HOST ARRANGEMENT
Data SMS Gateway
Host means
Communications interpreter
TCP/IP
SMS-C
Modem
Internet
11
16
14
12
10

Fig. 3

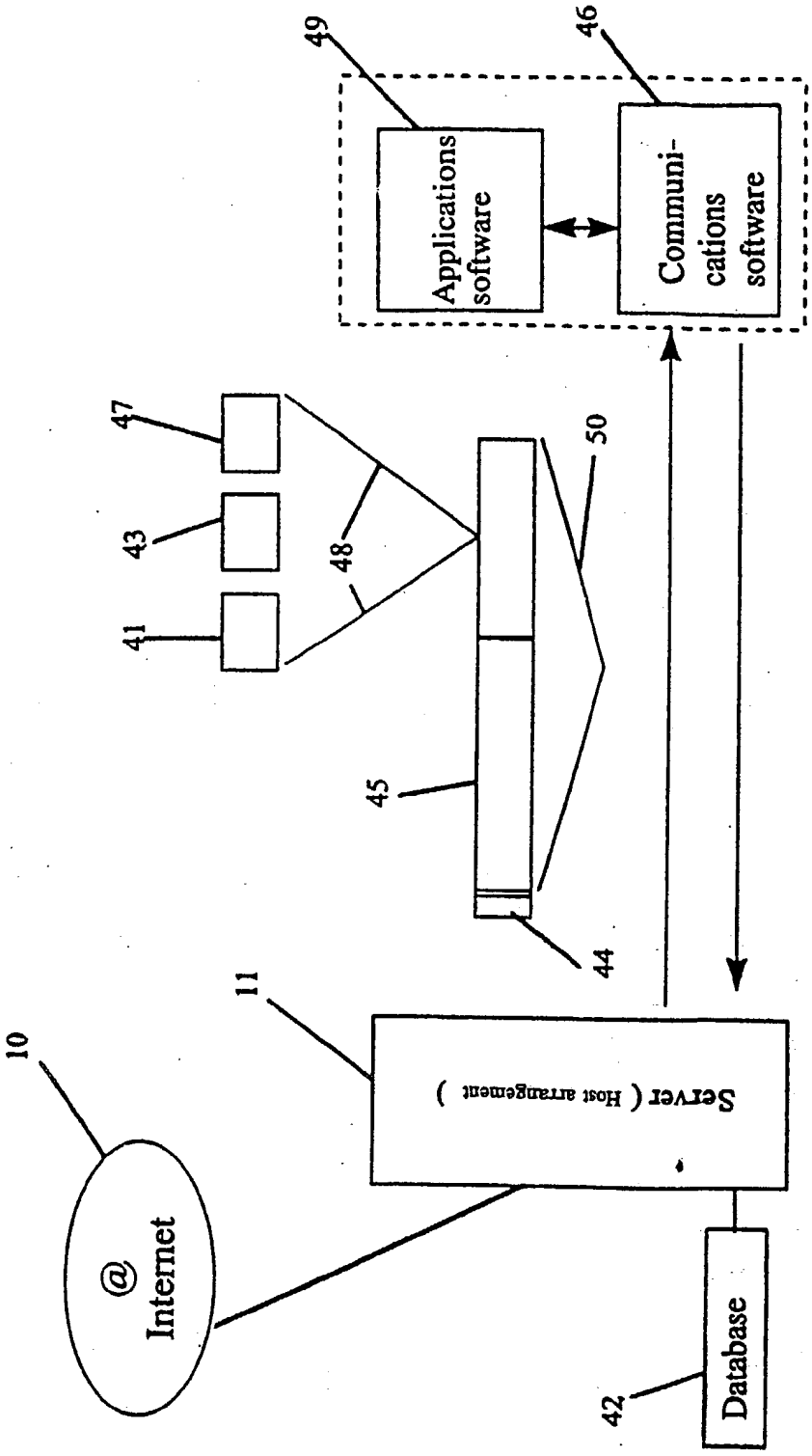
10
@ Internet
11
Server (Host arrangement)
42
Database
44
45
50
47
43
41
48
49
46
Applications software
Communi-cations software

Fig. 4

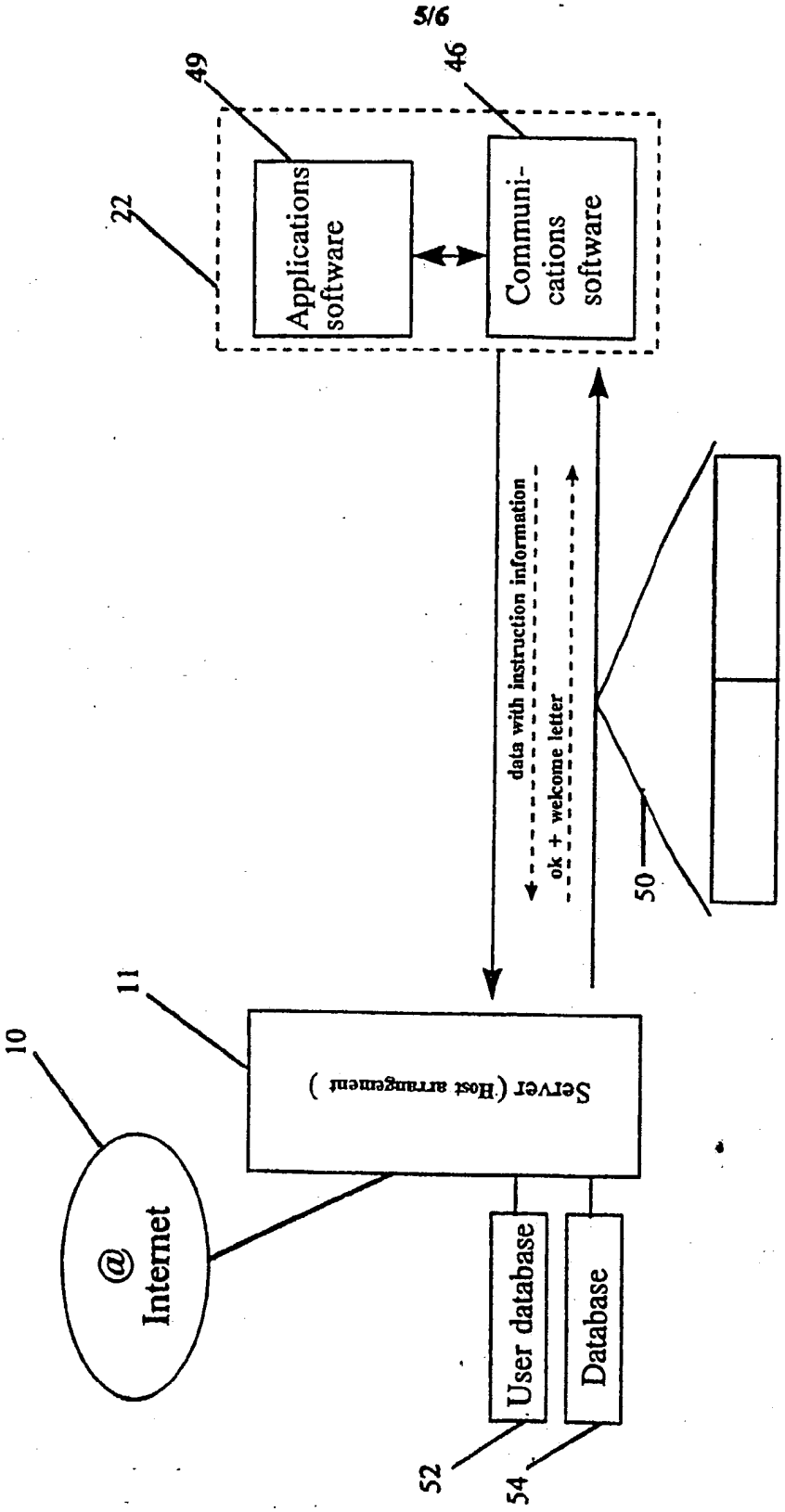
49
46
22
Applications software
Communi-cations software
data with instruction information
ok + welcome letter
50
11
10
Server (Host arrangement)
@ Internet
User database
Database
52
54

Fig. 5

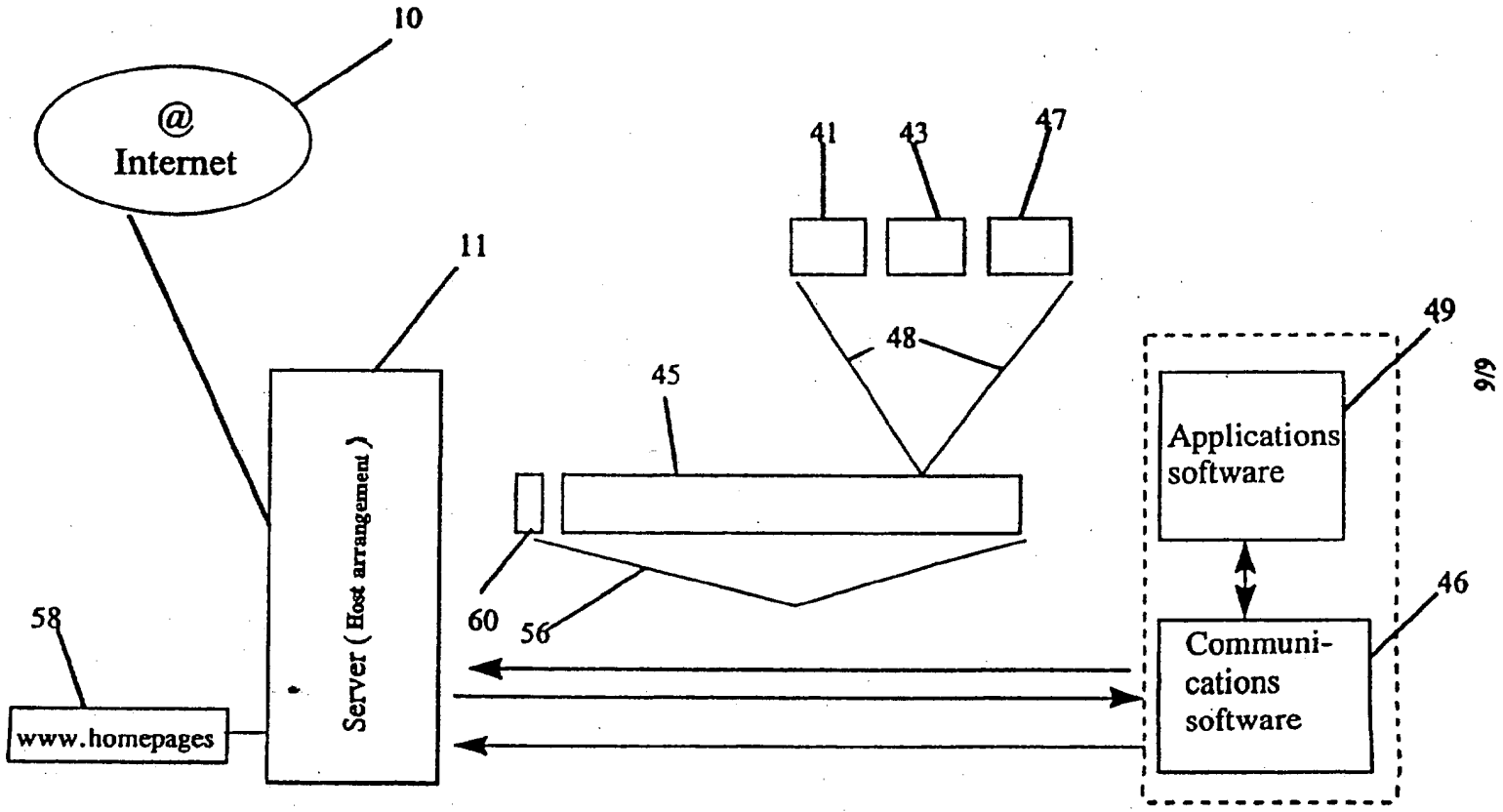
10
@
Internet
11
41
43
47
48
45
49
Applications
software
46
Communi-
cations
software
58
www.homepages
Server (Host arrangement)
60
56

Fig. 6

INTERNATIONAL SEARCH REPORT

International application No.
PCT/SE 96/01077

A. CLASSIFICATION OF SUBJECT MATTER

IPC6: H04Q 7/22, H04Q 7/32, H04L 12/58
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC6: H04Q, H04L

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

SE,DK,FI,NO classes as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 5353328 A (MATTI JOKIMIES), 4 October 1994 (04.10.94), column 3, line 3 - line 28	1-14
A	US 5351235 A (PEKKA LAHTINEN), 27 Sept 1994 (27.09.94), column 5, line 15 - line 23; column 5, line 54	1-14

☐ Further documents are listed in the continuation of Box C. ☒ See patent family annex.

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Date of the actual completion of the international search	Date of mailing of the international search report
29 October 1996	05 -12- 1996
Name and mailing address of the ISA/ Swedish Patent Office Box 5055, S-102 42 STOCKHOLM Facsimile No. +46 8 666 02 86	Authorized officer Marcus Wik Telephone No. +46 8 782 25 00

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Information on patent family members

01/10/96

International application No.
PCT/SE 96/01077

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US-A- 5353328	04/10/94	AU-B- 665047	14/12/95
		AU-A- 3294393	19/08/93
		EP-A,B- 0555992	18/08/93
		JP-A- 5284246	29/10/93
US-A- 5351235	27/09/94	AT-T- 138769	15/06/96
		AU-B- 663482	12/10/95
		AU-A- 1190892	07/09/92
		DE-D- 69211147	00/00/00
		EP-A,B- 0609209	10/08/94
		SE-T3- 0609209	
		FI-B,C- 94581	15/06/95
		WO-A- 9214329	20/08/92

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INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification 6 : H04Q 7/22, H04L 12/56 — A1

(11) International Publication Number: **WO 97/26764**

(43) International Publication Date: 24 July 1997 (24.07.97)

(21) International Application Number: PCT/FI97/00020

(22) International Filing Date: 15 January 1997 (15.01.97)

(30) Priority Data:
960211 16 January 1996 (16.01.96) FI

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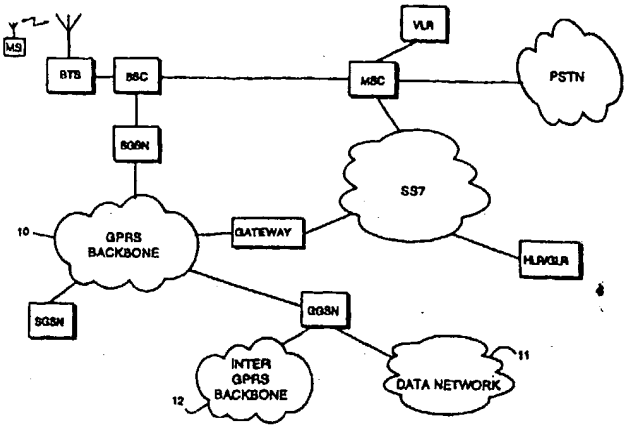
(81) Designated States: AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, CA, CH, CN, CU, CZ, DE, DK, EE, ES, FI, GB, GE, HU, IL, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MD, MG, MK, MN, MW, MX, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, TJ, TM, TR, TT, UA, UG, US, UZ, VN, ARIPO patent (KE, LS, MW, SD, SZ, UG), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, ML, MR, NE, SN, TD, TG).

Published

With international search report.

Before the expiration of the time limit for amending the claims and to be republished in the event of the receipt of amendments.

(54) Title: DIGITAL MOBILE COMMUNICATION SYSTEM AND METHODS FOR PROCESSING A TERMINATING CALL



(57) Abstract

A radio interface is provided in packet radio system (SGSN, GGSN, 10) by means of a digital mobile communication network (BTS, BSC, MSC, HLR). A dual-mode terminal equipment (MS) is capable of operating both in the mobile state and in the packet radio state but it monitors different control channels in these states. There is information in the subscriber database (HLR) of the mobile communication network that the mobile station (MS) is not available when it is in the packet radio state. This enables call forwarding and appropriate announcements in connection with mobile-terminating calls. There may also be information in the subscriber database (HLR) that the mobile station is in the packet radio state. In that case the subscriber database (HLR) of the mobile communication network may send a notification to the mobile station (MS) via the packet radio network (SGSN, GGSN, 10) that the mobile station should transit to the mobile state for receiving an incoming call.

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Digital mobile communication system and methods for processing a terminating call

Field of the Invention

The present invention relates to mobile communication systems to which a packet radio network is connected.

Background of the Invention

Mobile communication systems have been developed as it has become necessary to make people free to move away from fixed telephone terminals without making their availability more difficult. At the same time as the use of different data transmission services has increased in offices, various data services have also been introduced to mobile communication systems. Portable computers allow effective data processing wherever the user is moving. The mobile communication networks, in turn, provide the user with an effective access network for mobile data transmission, the network giving access to actual data networks. For this purpose new data service modes are being designed for present and future mobile communication networks. Digital mobile communication systems, such as the pan-European mobile communication system GSM (Global System for Mobile Communication) support mobile data transmission particularly well.

General Packet Radio Service GPRS is a new service in the GSM system and it is one of the subjects of standardization of GSM phase 2+ at ETSI (European Telecommunication Standard Institute). A GPRS operational environment comprises one or more subnetwork service areas which are connected to one another by GPRS Backbone Network. A subnetwork comprises a set of packet data service nodes SN which

are herein referred to as serving GPRS support nodes SGSN. Each SGSN is connected to the GSM mobile communication network (typically to base station systems) so that it is able to provide a packet data service for mobile data terminal equipments via several base stations, that is, cells. The intermediate mobile communication network provides packet switched data transmission between support node and mobile data terminal equipments. Different subnetworks are, in turn, connected to an external data network, e.g. to a packet switched public data network PSPDN, via special GPRS gateway support nodes GGSN. Therefore by means of GPRS service the packet data transfer is provided between mobile data terminal equipments and external data networks while the GSM network acts as an access network. One feature of the GPRS service network is that it operates almost independently of the GSM network beside "ordinary" GSM network services.

In the GPRS GSM network there may be mobile stations MS (class B and C mobile stations) which may operate both normally in the GSM network and also in the GPRS network. In the present application the mode of operation in which the mobile station operates in the GPRS network (data transmission over a packet-switched connection, the so-called Active state in GPRS terms), is referred to as GPRS state, and the mode of operation in which the mobile station operates in the GSM network is referred to as GSM state (data or speech transmission over a circuit-switched connection, the so-called Idle state in GPRS terms). The MS transits from the GSM state (Idle) to the GPRS state (Active) by initiating a GPRS Logon procedure and from the GPRS state (Active) to the GSM state (Idle) by initiating a GPRS Logoff procedure. When the MS is in the GPRS state (Active), it may either actively transmit and receive

messages or be "idle". As in the GPRS state the MS is most of the time idle, it may monitor normal GSM paging channels and react to circuit switched mobile terminating calls, for example. It may not be possible to monitor GSM channels during the packet data transmission. Therefore the MS may not be reached. As data transmission activity of the MS in the GPRS state is not known accurately, it is neither known exactly if the MS receives GSM pagings or not. If the MS does not receive a paging message, the GSM network may conclude the presence of a fault situation, as on the basis of subscriber data of the GSM network, the MS should be available. The normal situation will not be restored until the MS returns to GSM state (Idle). This "indefinite" availability of the MS is a problem both for a mobile subscriber and for the GSM network and the calling subscriber. A similar problem may arise also in other packet radio networks that are built on top of a conventional mobile communication network.

Brief Summary of the Invention

One object of the present invention is to eliminate this problem.

The present invention relates to a digital mobile communication system comprising

a mobile communication network containing a mobile services switching centre, base station systems, and a subscriber database for maintaining subscriber data and location data of mobile communication network subscribers,

a packet radio network containing packet radio support nodes, each of which is connected to the mobile communication network and to one or more of the remaining packet radio support nodes, and at least one gateway support node which provides an access point for

an external data network or to another packet radio system,

first control channels which are allocated to the use of the mobile communication network in base station systems,

second control channels which are allocated to the use of the packet radio network in base station systems,

a mobile terminal equipment having a first operating state where it monitors said first control channels, and a second operating state where it monitors said second control channels. According to the invention, the subscriber database of the mobile communication network has information that the mobile terminal equipment is not available via the first control channels when the mobile terminal equipment is in said second operating state.

The present invention also relates to methods for processing a mobile-terminating call in a digital mobile communication system comprising a mobile communication network; a packet radio network containing packet radio support nodes, each of which is connected to the mobile communication network which provides a radio interface for the packet radio network; first control channels allocated to the use of the mobile communication network in the radio interface; second control channels allocated to the use of the packet radio network in the radio interface; and a mobile terminal equipment having a first operating state where it monitors said first control channels, and a second operating state where it monitors said second control channels.

The first method comprises the steps of:

updating in the subscriber database of the mobile communication network information on that the

receiving the notification,

continuing call set-up in the mobile communication network via the first control channels.

The third method comprises the step of:

maintaining in the subscriber database of the mobile communication network information on that the mobile terminal equipment is capable of operating or authorized to operate in the second operating state,

a mobile-terminating call in the mobile communication network,

making an inquiry into said subscriber database,

in response to the information in said database (HLR), transmitting a notification of an incoming call to the mobile communication network via the packet radio network to the mobile terminal equipment,

the mobile terminal equipment transiting to monitor the first control channels in response to receiving the notification,

the call set-up is continued in the mobile communication network via the first control channels.

The basic idea of the present invention is to produce information for the actual mobile communication network on that it is not completely certain that the mobile station is available for conventional calls when the mobile station is in the packet radio state. By means of the availability information, the mobile communication network is capable of giving the appropriate response (e.g. the mobile station busy or beyond the coverage area) to the calling subscriber and perform a call forwarding for MT calls, for example.

In one embodiment of the invention, the mobile station itself, when transiting to the packet radio state, signals to the mobile communication network that

it is not available for conventional mobile communication services. The mobile communication network stores this availability information as normal to the subscriber data. When departing from the packet radio state, the mobile station signals to the mobile station that it is available again. This takes place preferably by conventional signalling which can be used in the mobile communication network for this purpose, such as IMSI Detach and IMSI Attach messages in the GSM system.

In the second embodiment of the invention, the mobile communication network deduces the status information of the mobile station from that the mobile station logins to a packet radio state in a packet radio subscriber register. In that case the mobile station need not separately signal the information. Furthermore, the subscriber data may contain the reason for being unavailable, that is, the packet radio state.

These embodiments of the invention overcome the problem relating to the "indefiniteness" of the availability of a mobile station: now the mobile communication network knows unambiguously that the mobile station is not available for normal calls. However, some of the availability problem still remains, even more acutely than before: if the user holds the mobile station long in the packet radio state, he/she is not able to receive MT calls even when he/she has not transmitted even one data packet in all that time.

This problem can be further relieved in a still further embodiment of the invention. There is information in the mobile communication network that the mobile station is in the packet radio state and thus unavailable for normal calls. When in the MT call set-up, the location of the mobile subscriber is

General Packet Radio Service in the pan-European digital mobile communication system GSM (Global System for Mobile Communication) or in similar mobile communication systems, such as DCS1800 and PCN (Personal Communication Network). In the following, the preferred embodiments of the invention will be explained by means of the GPRS packet radio network provided by the GPRS service and the GSM system, without restricting the invention to this specific packet radio system.

Figure 1 illustrates the GPRS packet radio network implemented into the GSM system.

The basic structure of the GSM network comprises two parts: a base station system BSS and a network subsystem (NSS). The BSS and the mobile stations MS communicate over radio links. In the base station system BSS each cell is served by a base station BTS. A set of base stations is connected to a base station controller BSC whose function is to control the radio frequencies and the channels of the BTS. The BSCs are connected to a mobile services switching centre MSC. Specific MSCs are connected to other telecommunication networks, such as public switched telephone network PSTN, and contain gateway functions for incoming calls from the networks and outgoing calls to the networks. These MSCs are known as gateway MSCs (GMSC).

There are two main types of databases associated with call routing. The home location register HLR stores the subscriber data of all subscribers of the network permanently or semipermanently, including information on the services the subscriber may have access to, and on the present location of the subscriber. Visitor location register VLR is the other register type. A VLR is generally

connected to one MSC but it may, however, serve several MSCs. It is a general practice that the VLR is integrated into the MSC. This integrated network element is known as visitor MSC (VMSC). Whenever the mobile station MS is active (registered and capable of making or receiving calls), most of the mobile subscriber data relating to the mobile station MS maintained in the HLR, is copied into the VLR of the MSC in whose area the MS is located. With regard to a more detailed description of the GSM system, a reference is made to the ETSI/GSM Specifications and to *The GSM System for Mobile Communications*, by M. Mouly & M. Pautet, Palaiseau, France, 1992, ISBN:2-9507190-0-0-7.

In Figure 1 the GPRS network connected to the GSM network comprises two serving GPRS support nodes (SGSN) and one GPRS gateway support node (GGSN). These different support nodes SGSN and GGSN are connected to one another by Intra-Operator Backbone Network. It is to be understood that the GPRS network may have any number of support and gateway nodes. It may also have so-called home support nodes HGSN although as a rule, the HGSN functions are integrated into the GGSN.

Each support node SGSN manages a packet data service in the area of one or more cells in a cellular packet radio network. For this purpose, each support node SGSN is connected to a specific local section of the GSM mobile communication system. This connection is typically made into the mobile services switching centre MSC, but in some situations it may be advantageous to make the connection directly to the base station system BSS, that is, to the base station controllers BSC or to one of the base stations BTS. The mobile station MS in the cell communicates over the radio interface with the base station BTS and further

through the mobile communication network with the support node SGSN whose service area the cell belongs to. In principle, the mobile communication network between the support node SGSN and the mobile station MS only transmits packets between these two. The mobile communication network may for this purpose provide either a circuit-switched connection or a transmission of packet-switched data packets between the mobile station MS and the serving support node SGSN. An example of a circuit-switched connection between the mobile station and the support node (Agent) is shown in Finnish Patent Application 934,115. An example of a packet-switched data transfer connection between the mobile station and the support node (Agent) is shown in Finnish Patent Application 940,314. It should be noted that the mobile communication network provides only a physical connection (access network) between the mobile station and the support node SGSN and its exact operation and structure are not of essential significance for the invention.

The intra-operator backbone network 10, which inter-connects the operator's equipments SGSN and GGSN, can be implemented by a local network, for example. It is to be noted that it is also possible to implement the operator's GPRS network without an intra-operator backbone network, for example by implementing all the features into one computer, but this modification does not cause any alterations to the principles of call set-up according to the invention.

The GPRS gateway support node GGSN inter-connects the operator to the GPRS network of the other operators of the GPRS network and to data networks, such as Inter-Operator Backbone Network 12, IP network or X.25 network 11. An interworking function IWF may be located between the gateway support node GGSN and other

networks. The backbone network 12 between the operators is a network via which the gateway support nodes GGSN may communicate with each other. This communication is required to support GPRS roaming between different GPRS networks.

The gateway support node GGSN is also used for storing the location information of the GPRS mobile station. The GGSN also routes mobile-terminating (MT) data packets. The GGSN also contains a database which maps together the network address of the mobile station, e.g. in IP network, in X.25 network, in CLNP network or simultaneously in several of them and the mobile station identifier in the GPRS network. When the mobile station moves from one cell to another within the area of one support node SGSN, location updating must be done only in the support node SGSN and there is no need for informing the GGSN of the change of location. When the mobile station moves from one cell of the support node SGSN to another SGSN cell in the area of the same or different operator, updating is carried out also for the (home) gateway support node GGSN for storing the new visitor support node identifier and the mobile station identifier.

The GPRS register GR is used for authenticating the subscribers at the beginning of a GPRS session. It contains a mapping between the packet data protocol (PDP) address (addresses) of the subscriber and the IMSI (International Mobile Subscriber Identity) of the subscriber. In the GSM network the subscriber is identified by means of the IMSI. The GR may be a separate register or it may be preferably integrated into the home location register HLR in the mobile communication system. In Figure 1 the HLR/GR is connected via the SS7 (Signalling System 7) to the MSC and the intra-operator backbone network.

There may be a direct connection or an SS7 gateway node GATEWAY between the SS7 signalling system and the intra-operator backbone network. In this way the HLR/GR may in principle exchange packet-switched messages with any GPRS node. The communication method of the HLR/GR and the connection between the GPRS network is not, however, essential for the invention. Alternatively, there may be, for example, a direct connection to one of the nodes, or the GR is one node in the GPRS network.

When the MS transits to the GPRS state (where data can be transferred over a packet-switched connection), it initiates the GPRS Logon procedure. In the procedure, the MS requests access to the GPRS network and sends its identity IMSI to the serving support node SGSN. The serving SGSN makes an inquiry into the HLR on the basis of the IMSI. The HLR initiates a GSM type of challenge-response authentication in the packet radio network. This includes generation and sending of an authentication triplet to the GPRS network. After authentication, the MS registers as the user of a specified data network (such as 11) and its address. This registration is performed along with the GR.

In the GPRS GSM network there may be mobile stations MS (class B or C mobile stations) which may be either in the GPRS state or in the GSM state (data or speech transmission over a circuit-switched connection). The MS transits from the GSM state to the GPRS state by initiating the GPRS Logon procedure and from the GPRS state to the GSM state by initiating the GPRS Logoff procedure. As the MS is in the GPRS state most of the time idle, it could still monitor normal GSM pagings (e.g. for setting up a mobile-terminating (MT) speech call), but it cannot be guaranteed that the MS will receive the paging messages. If the MS does not

receive the paging message, the GSM network may deduce the presence of a fault situation as the MS should be available according to the subscriber data in the GSM network. The normal situation will not be restored until the MS returns to the GSM state.

In the present invention, information is produced in the home location register HLR of the GSM network on that the mobile station is not available for ordinary calls when it transits to the packet radio state. By means of this information, the mobile communication network is able to give an appropriate response (e.g. the mobile station busy or beyond the coverage area) to the calling subscriber and to perform call forwarding in MT calls or to interrupt call set-up. The signalling diagrams of Figures 2 and 3 show an example of two alternative methods for updating presence/absence information of the mobile station in the HLR and for processing an MT call.

In the embodiment of Figure 2, the MS itself is arranged, before transiting to the packet radio state, to signal to the GSM network that it is not available for conventional mobile services. This takes place e.g. by an IMSI Detach message according to GSM recommendations that is normally used for informing that the MS has departed from the network (e.g. as a result of the mobile station being switched off). This message does not normally contain information on the reason of absence but it can provided with this information when required. The MS signals an IMSI Detach message on the GSM channel via the base station system BSS to the mobile services switching centre MSC that forwards the IMSI Detach information to the HLR. The HLR updates in the subscriber data that the mobile subscriber (MS) is not available (MS Detached).

After this, the MS performs on the GPRS

channel registration to the GPRS network with the GPRS Logon procedure. In this way the MS has transitted from the GSM state to the GPRS state where it monitors primarily or solely GPRS channels.

An MT call is received at the MSC from the public switched telephone network, for example. The MSC makes a normal routing data inquiry into the HLR (an HLR inquiry). The HLR detects from the subscriber data that the MS is not available and signals this information in response to the MSC. The MSC gives an appropriate announcement to the calling subscriber and terminates call set-up or performs a call forwarding, for example. The information on the activated call forwarding and the call forwarding number are obtained in the response of the HLR.

At some stage the MS terminates the registration to the GPRS network by carrying out a GPRS Logoff procedure on the GPRS channel. When transiting back to the GSM state, the MS signals once more to the GSM network that it is available again. This takes place by an IMSI Attach message according to the GSM recommendation, for example. The MS sends an IMSI Attach message on the GSM channel via the base station system BSS to the MSC which forwards the IMSI Attach information to the HLR. The HLR updates in the subscriber data information on that the mobile subscriber (MS) is available (MS Attached). The MT calls received after that are processed as in normal call set-up in the GSM system.

According the second embodiment of the invention, absence information is produced in the HLR in another way which does not require that the MS signals separately the information on GSM channels. Instead, the HLR receives information via the GPRS network. There are several alternatives for this, some

of which are shown in the following.

1) The MS itself signals the information directly to the HLR in a data packet (GPRS IMSI Attach, GPRS IMSI Detach).

2) The MS signals the information to the SGSN (e.g. GPRS Logon, GPRS Logoff) which informs it further to the HLR.

3) The MS signals the information to the SGSN (e.g. GPRS Logon, GPRS Logoff) which informs it further to the GR and the GR to the HLR.

4) The MS signals the information to the SGSN (e.g. GPRS Logon, GPRS Logoff) which informs it further to the GR. The HLR makes an inquiry into the GR in the case of an MT call on subscribers capable of transiting to the GPRS state.

5) The SGSN detects that the MS has departed from the GPRS state (e.g. because it does not acknowledge the transmitted data packets). This kind of situation may arise when the battery of the MS runs out before it has time to signal its departure. The SGSN signals the information to the HLR or to the GR as in steps 2 to 4.

As an alternative to the above, any other method may be used by means of which the HLR obtains information from the GPRS on the MS registering in or out.

The signalling diagram of Figure 3 illustrates more exactly one method for producing the MS presence/absence information in the HLR by GPRS Logon and Logoff procedures, and for processing an MT call. When transiting from the GSM state to the GPRS state, the MS registers into the GPRS network by the GPRS Logon procedure. This includes an authentication procedure in which the HLR (and/or GR) participates, as well. It may be deduced from this authentication

procedure that the MS has assumed the GPRS state and it is no longer available for normal GSM services. As a result of this, the HLR updates in the subscriber data that the mobile subscriber (MS) is not available (MS Detached) and possibly the reason (GPRS Logon) as well. If then an MT call arrives from the PSTN to the MS, the MSC makes an HLR inquiry and receives in response "the MS not available" as in the case of Figure 2. At some stage the MS registers from the GPRS network by a Logoff procedure in which the SGSN and the GGSN are signalled that they can delete their information relating to the MS. At the same time the GSM informs either directly the HLR or then the GR which, in turn, informs the HLR. The HLR updates in the subscriber data that the mobile subscriber (MS) is again available (MS Attached).

Figure 4 is a signalling diagram illustrating the third embodiment of the invention where the MS is transmitted information via the GPRS network on that the MS is about to receive an MT call in the GSM network. In Figure 4 the MS first registers into the GPRS network by the GPRS Logon procedure, whereby the HLR is updated information on that the MS is not available via normal GSM paging channels because it is in the GPRS state. This procedure is similar to what was explained above in connection with Figure 3. Alternatively, any method can be used with which information is updated in the HLR on that the MS is in the GPRS network. The MSC receives an MT call from the PSTN to said MS. The MSC makes a normal routing information inquiry into the HLR. The HLR detects in the subscriber data that the MS is registered into the GPRS network. As a result of this information, the HLR informs the MS via the GPRS network that the MS is about to receive a paging via the GSM channels. This

notification may be transmitted in several different ways, some of which will be explained in more detail below.

According to the third embodiment of the invention, the HLR sends a notification to the MS via the GPRS network that it is receiving an MT call on GSM channels. This may be carried out when the HLR has information or it receives information by an inquiry made into the GPRS network that the MS is in the GPRS network. The HLR may also send via the GPRS network information on the MT calls whenever the MS has a right to GPRS services, regardless of whether the MS is in the GPRS network or not. In that case the HLR does not need presence/absence information but it is only in the GPRS network as normal. If the MS is not in the GPRS network, the GPRS network cannot forward the notification but it will be "lost". If the MS is in the GPRS network, the network transmits the notification to the destination. In both cases the GSM has continued call set-up on GSM channels.

In the embodiment of Figure 4, it is assumed that the HLR also contains the address of the support node that serves the MS. In that case the HLR with a connection to the GPRS support nodes (e.g. via the SS7 system) may send to the serving support node a data packet informing of the incoming call. Alternatively, the HLR may send to the gateway support node a data packet with the MS data network address or some general address on the basis of which the GGSN can route the data packet to the service support node SGSN. In that case the address has to be stored in the HLR or the HLR has to be able to retrieve it by a GR inquiry. A further alternative is that the HLR informs the GR of an incoming call to a specific IMSI, whereby the GR generates and transmits a data packet (containing the

notification according to the invention) provided with the MS data network address to the service support node SGSN either directly or via the gateway support node GGSN.

When information of an incoming GSM call has been (by some appropriate way) forwarded to the serving support node, it sends a data packet on the packet radio channel to the mobile station informing of the MT call on GSM channels. In this way the MS is aware of the incoming MT call and may start to monitor GSM paging channels. This may be unconditional, or the mobile station of the user may be given the opportunity to choose if the MT call is received or not. The MS may stay in the GPRS state, for example, if it has an ongoing active data transfer stage that is not to be interrupted.

If the MS transits to the GSM state, the support node SGSN should also be aware of it so that it can interrupt transmission via the GPRS channels. In the simplest case the serving support node SGSN automatically interrupts the transmission of information on the GPRS channel after having sent the notification of the incoming call according to the invention.

Another alternative is that the serving SGSN continues its transmission and interrupts the transmission only after having found out that the MS does not respond.

Still another alternative is that the MS, when transiting temporarily from the GPRS state, signals via the GPRS channel to the serving support node SGSN that data packets may not be transmitted to it as it is busy elsewhere. The serving SGSN (or some other unit in the GPRS network) may buffer or discard the data received in the meanwhile. In the last mentioned case the data

will not be lost altogether as the upper level of end to end connection protocols attend to retransmitting the data packets if the MS does not acknowledge them.

After having sent a notification via the GPRS network, the HLR sends a normal inquiry response to the MSC containing the roaming number of the mobile station. After this the call-set up for the MS, which has started to monitor GSM paging channels, will proceed according to ordinary GSM signalling on GSM channels.

The figures and the specification relating thereto are only intended to illustrate the present invention. In its details, the invention may vary within the scope and spirit of the attached claims.

Claims

1. A digital mobile communication system comprising

a mobile communication network containing a mobile services switching centre (MSC), base station systems (BSS,BTS), and a subscriber database (HLR) for maintaining subscriber data and location data of mobile communication network subscribers,

a packet radio network containing packet radio support nodes (SGSN), each of which is connected to the mobile communication network and to one or more of the remaining packet radio support nodes, and at least one gateway support node (GGSN) which provides an access point for an external data network or to another packet radio system,

first control channels which are allocated to the use of the mobile communication network in base station systems,

second control channels which are allocated to the use of the packet radio network in base station systems,

a mobile terminal equipment (MS) having a first operating state where it monitors said first control channels, and a second operating state where it monitors said second control channels,

c h a r a c t e r i z e d in that

the subscriber database (HLR) of the mobile communication network has information on that the mobile terminal equipment (MS) is not available via the first control channels when the mobile terminal equipment (MS) is in said second operating state.

2. A mobile communication system according to claim 1, c h a r a c t e r i z e d in that

the mobile terminal equipment (MS) is arranged

to signal on said first control channels the absence or presence information, respectively, to the mobile communication network when it moves from the first operating state to the second operating state or, correspondingly, from the second operating state to the first operating state,

the mobile communication network is arranged to update the absence or presence information signalled by the mobile terminal equipment (MS) to the subscriber database (HLR).

3. A mobile communication system according to claim 1 or 2, c h a r a c t e r i z e d in that

the subscriber database is arranged to receive or inquire the presence/absence information of the mobile terminal equipment (MS) of the packet radio network.

4. A mobile communication system according to claim 3, c h a r a c t e r i z e d in that

the packet radio network comprises a first registration procedure which the mobile terminal equipment (MS) performs upon transition to the second operating state, and a second registration procedure which the mobile terminal equipment performs via the second control channels when it departs from the second operating state,

in response to performing the first registration procedure in the packet radio network, the mobile communication network subscriber database (HLR) updates in the subscriber data that the mobile termination equipment (MS) is not available via the first control channels,

in response to performing the second registration procedure in the packet radio network, the mobile communication network subscriber database (HLR) updates in the subscriber data that the mobile

termination equipment (MS) is available via the first control channels.

5. A mobile communication system according to claim 1, 2, 3 or 4, c h a r a c t e r i z e d in that

information on that the mobile terminal equipment has registered into the packet radio network is associated with the information that the mobiles terminal equipment is not available via the first control channels.

6. A mobile communication system according to claim 1, 2, 3, 4 or 5, c h a r a c t e r i z e d in that

the mobile services switching centre (MSC), which receives a mobile-terminating call, is arranged to make an inquiry into the subscriber database (HLR),

the mobile services switching centre (MSC) is arranged to interrupt call set-up or make call forwarding when the subscriber database (HLR) has information that the mobile terminal equipment is not available via the first control channels.

7. A mobile communication system according to any one of claims 1 to 5, c h a r a c t e r i z e d in that

the mobile services switching centre (MSC), ~~which receives a mobile-terminating call, makes~~ an inquiry into the subscriber database (HLR),

in response to the information that the mobile terminal equipment (MS) is not available via the first control channels and registered into the packet radio network, the subscriber database is arranged to transmit a notification to the mobile terminal equipment (MS) via the packet radio network that it is about to receive a call in the mobile communication network,

the mobile communication network continues

call set-up via the first control channels.

8. A mobile communication system according to claim 1, c h a r a c t e r i z e d in that

said information comprises information that the mobile terminal equipment is authorized to operate or capable of operating in the packet radio network.

9. A mobile communication system according to claim 8, c h a r a c t e r i z e d in that

the mobile services switching centre (MSC), which receives a mobile-terminating call, is arranged to make an inquiry into the subscriber database (HLR),

in response to the information that the mobile terminal equipment (MS) is authorized to operate or capable of operating in the packet radio network, the subscriber database is arranged to transmit a notification to the mobile terminal equipment (MS) via the packet radio network that it is about to receive a call in the mobile communication network,

the mobile communication network continues call set-up via the first control channels.

10. A mobile communication system according to claim 7 or 9, c h a r a c t e r i z e d in that

in response to receiving said notification via the packet radio network, the mobile terminal equipment (MS) transits into the first operating state to monitor the first control channels.

11. A mobile communication system according to claim 10, c h a r a c t e r i z e d in that

the packet radio network is arranged to interrupt a data transmission to the mobile terminal equipment (MS) in one of the following ways:

- in response to sending said notification to the mobile terminal equipment,

- in response to a cease transmission message sent by the mobile terminal equipment,

- in response to the mobile terminal equipment not acknowledging the sent information.

12. A method for processing a mobile-terminating call in a digital mobile communication system comprising a mobile communication network; a packet radio network containing packet radio support nodes, each of which is connected to the mobile communication network which provides a radio interface for the packet radio network; first control channels allocated to the use of the mobile communication network in the radio interface; second control channels allocated to the use of the packet radio network in the radio interface; and a mobile terminal equipment having a first operating state where it monitors said first control channels, and a second operating state where it monitors said second control channels,

c h a r a c t e r i z e d by

updating in the subscriber database of the mobile communication network information on that the availability of the mobile terminal equipment via the first control channels is uncertain when the mobile terminal equipment transits from the first to the second operating state,

updating in the subscriber database of the mobile communication network information on that the mobile terminal equipment is available via the first control channels when the mobile terminal equipment returns from the second to the first operating state,

receiving a mobile-terminating call in the mobile communication network,

making an inquiry into said subscriber database,

interrupting call set-up or making call forwarding if the subscriber database comprises information that the availability of the mobile

terminal equipment is uncertain.

13. A method for processing a mobile-terminating call in a digital mobile communication system comprising a mobile communication network; a packet radio network containing packet radio support nodes, each of which is connected to the mobile communication network which provides a radio interface for the packet radio network; first control channels allocated to the use of the mobile communication network in the radio interface; second control channels allocated to the use of the packet radio network in the radio interface; and a mobile terminal equipment having a first operating state where it monitors said first control channels, and a second operating state where it monitors said second control channels,

c h a r a c t e r i z e d by

updating in the subscriber database of the mobile communication network information on that the mobile terminal equipment is in the packet radio network and its availability via the first control channels is uncertain when the mobile terminal equipment transits from the first to the second operating state,

receiving a mobile-terminating call in the mobile communication network,

making an inquiry into said subscriber database,

in response to said information in the subscriber database (HLR), transmitting a notification to the mobile terminal equipment via the packet radio network that it is about to receive a call in the mobile communication network,

the mobile terminal equipment transiting to monitor the first control channels in response to receiving the notification,

continuing call set-up in the mobile communication network via the first control channels.

14. A method for processing a mobile-terminating call in a digital mobile communication system comprising a mobile communication network; a packet radio network containing packet radio support nodes, each of which is connected to the mobile communication network which provides a radio interface for the packet radio network; first control channels allocated to the use of the mobile communication network in the radio interface; second control channels allocated to the use of the packet radio network in the radio interface; and a mobile terminal equipment having a first operating state where it monitors said first control channels, and a second operating state where it monitors said second control channels,

c h a r a c t e r i z e d by

maintaining in the subscriber database of the mobile communication network information on that the mobile terminal equipment is capable of operating or authorized to operate in the second operating state,

receiving a mobile-terminating call in the mobile communication network,

making an inquiry into said subscriber database,

in response to said information in the subscriber database (HLR), transmitting a notification to the mobile terminal equipment via the packet radio network that it is about to receive a call in the mobile communication network,

the mobile terminal equipment transiting to monitor the first control channels in response to receiving the notification,

continuing call set-up in the mobile communication network via the first control channels.

15. A method according to claim 12, 13 or 14, c h a r a c t e r i z e d by

signalling from the mobile terminal equipment to the mobile communication network on said first control channels absence or presence information, respectively, when the mobile terminal equipment transits from the first operating state to the second operating state or, correspondingly, from the second operating state to the first operating state,

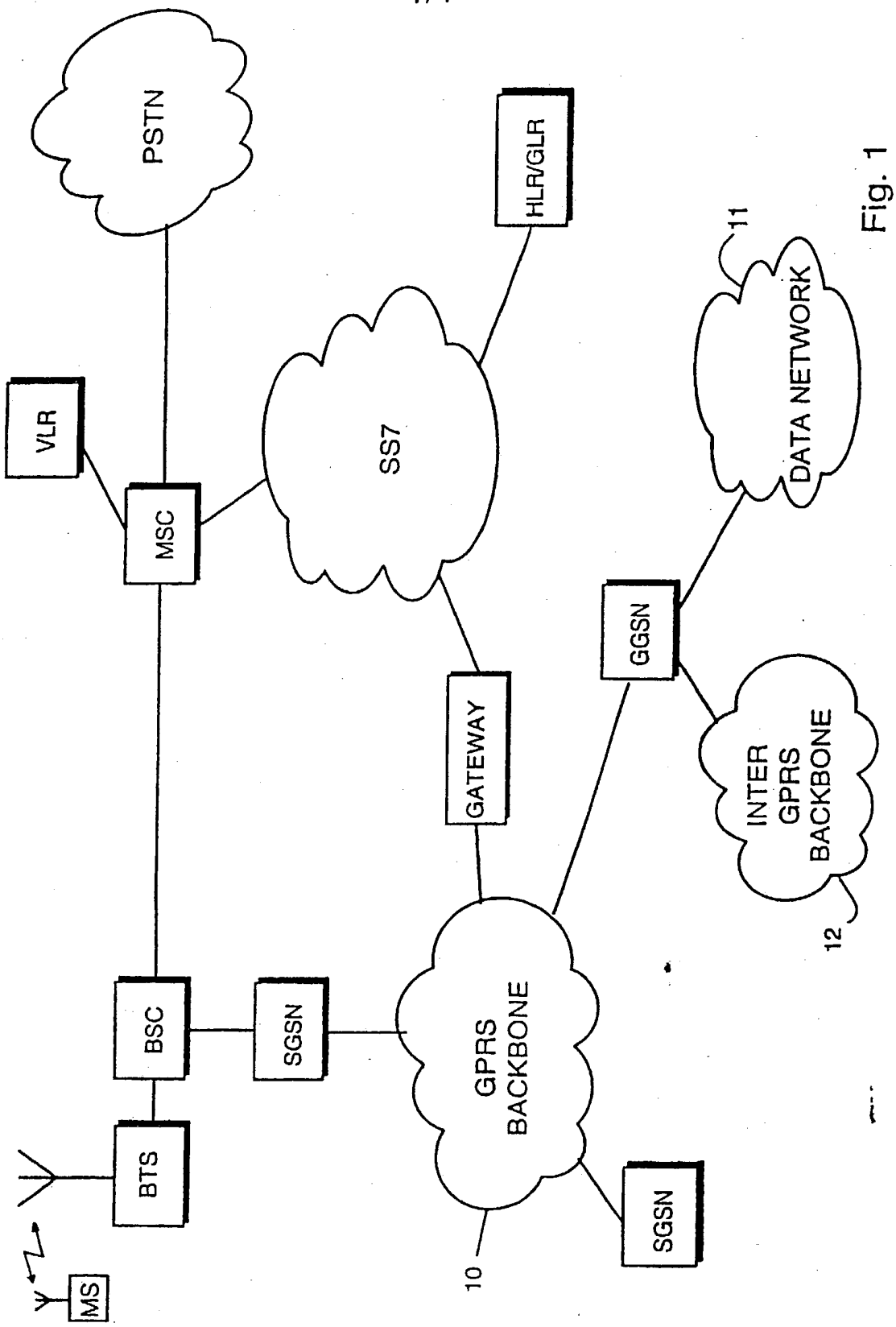
updating absence or presence information in the subscriber database.

16. A method according to claim 13, 14 or 15, c h a r a c t e r i z e d by

making the first registration procedure via the second control channels to the packet radio network when the mobile terminal equipment transits to the second operating state,

making the second registration procedure via the second control channels in the packet radio network when the mobile terminal equipment departs from the second operating state,

updating absence or presence information, respectively, in the subscriber database of the mobile communication network in response to making the first or, correspondingly, the second registration procedure in the packet radio network.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HLR/GLR
VLR
MSC
SS7
11
DATA NETWORK
GGSN
GATEWAY
INTER
GPRS
BACKBONE
12
BSC
SGSN
GPRS
BACKBONE
BTS
SGSN
MS
10

Fig. 1

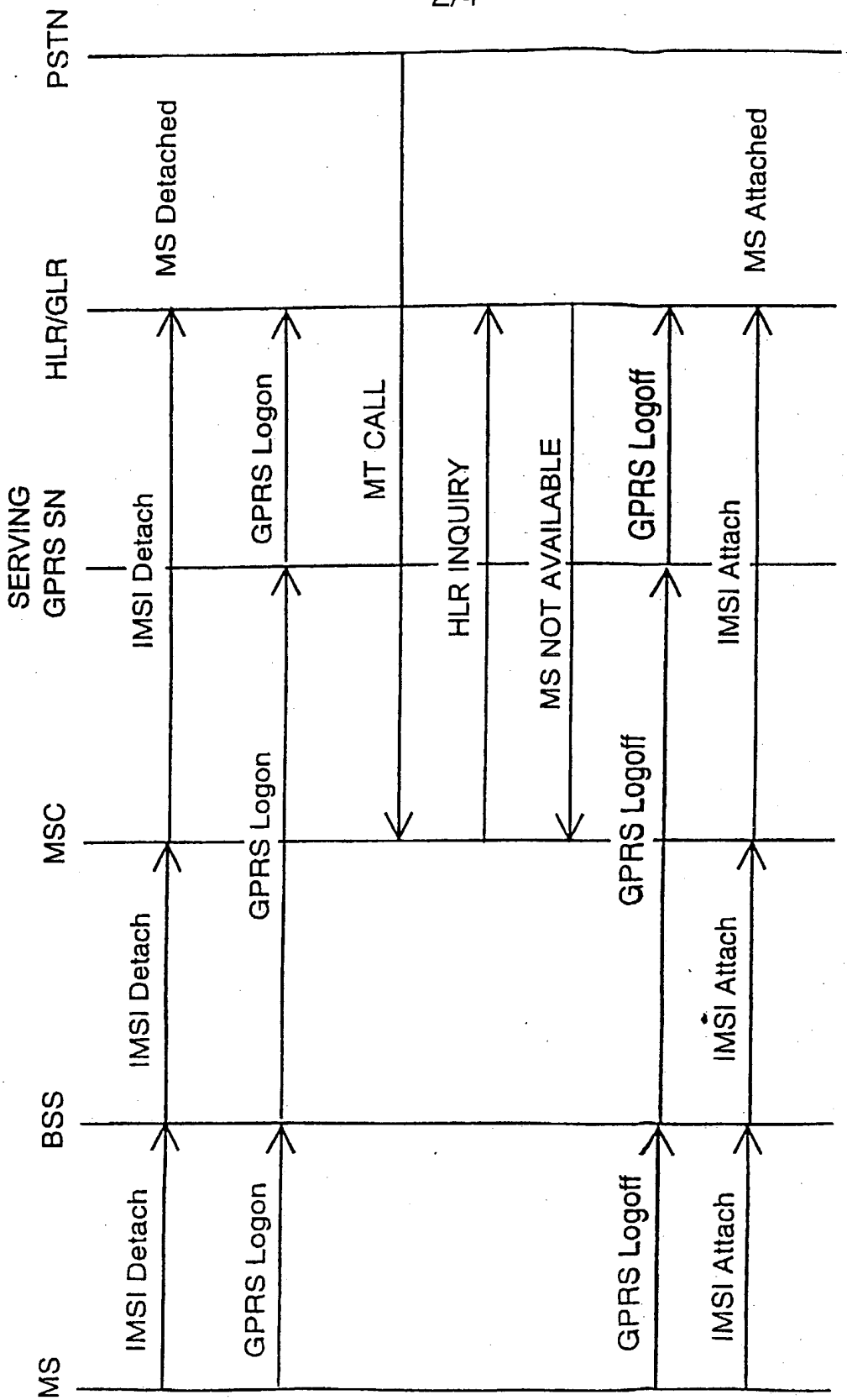
PSTN
HLR/GLR
SERVING GPRS SN
MSC
BSS
MS
MS Detached
MS Attached
IMSI Detach
GPRS Logon
MT CALL
HLR INQUIRY
MS NOT AVAILABLE
GPRS Logoff
IMSI Attach
IMSI Detach
GPRS Logon
GPRS Logoff
IMSI Attach
IMSI Detach
GPRS Logon
GPRS Logoff
IMSI Attach

Fig. 2

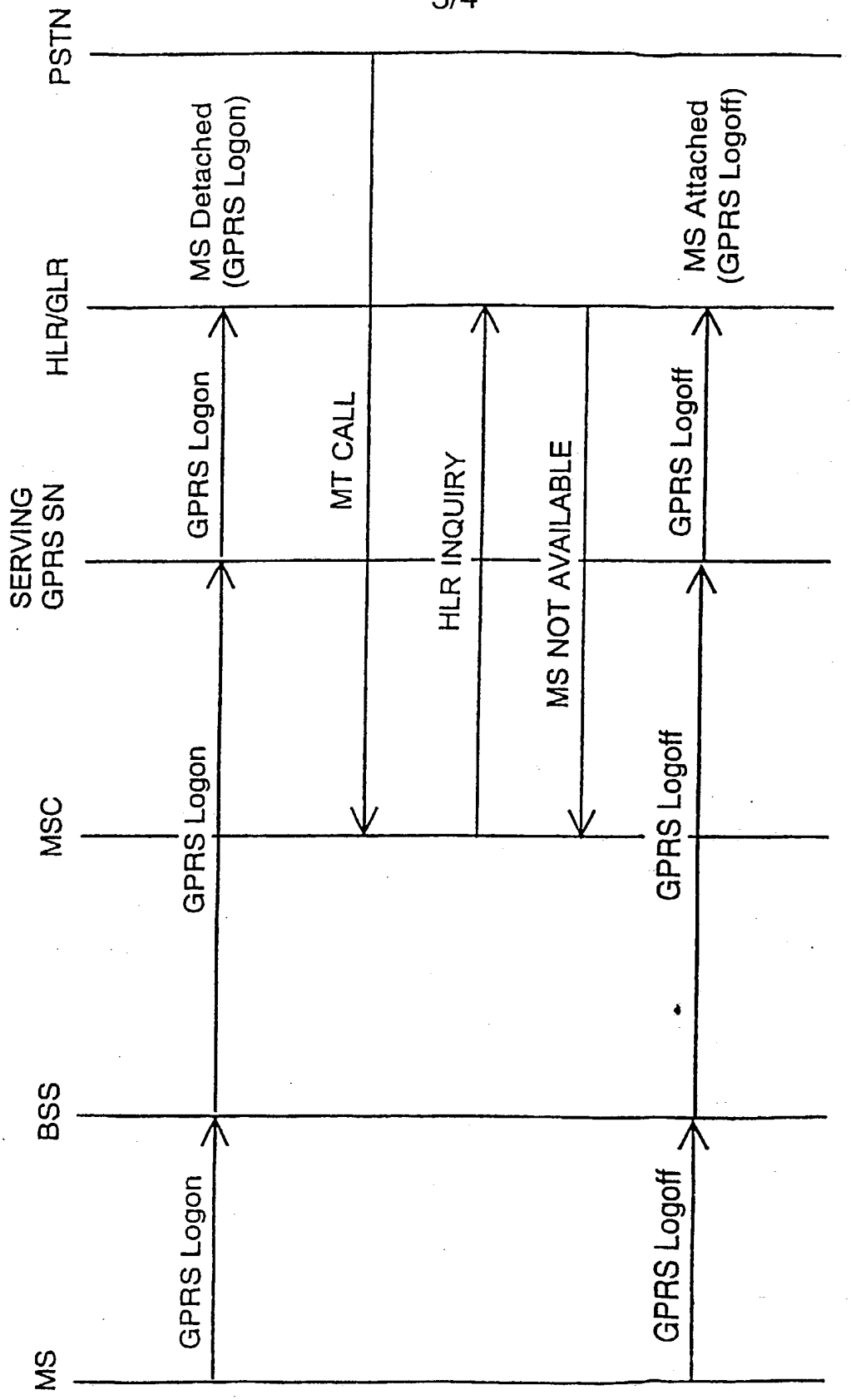
PSTN
HLR/GLR
SERVING GPRS SN
MSC
BSS
MS
MS Detached (GPRS Logon)
MS Attached (GPRS Logoff)
GPRS Logon
GPRS Logon
GPRS Logon
GPRS Logon
MT CALL
HLR INQUIRY
MS NOT AVAILABLE
GPRS Logoff
GPRS Logoff
GPRS Logoff
GPRS Logoff

Fig. 3

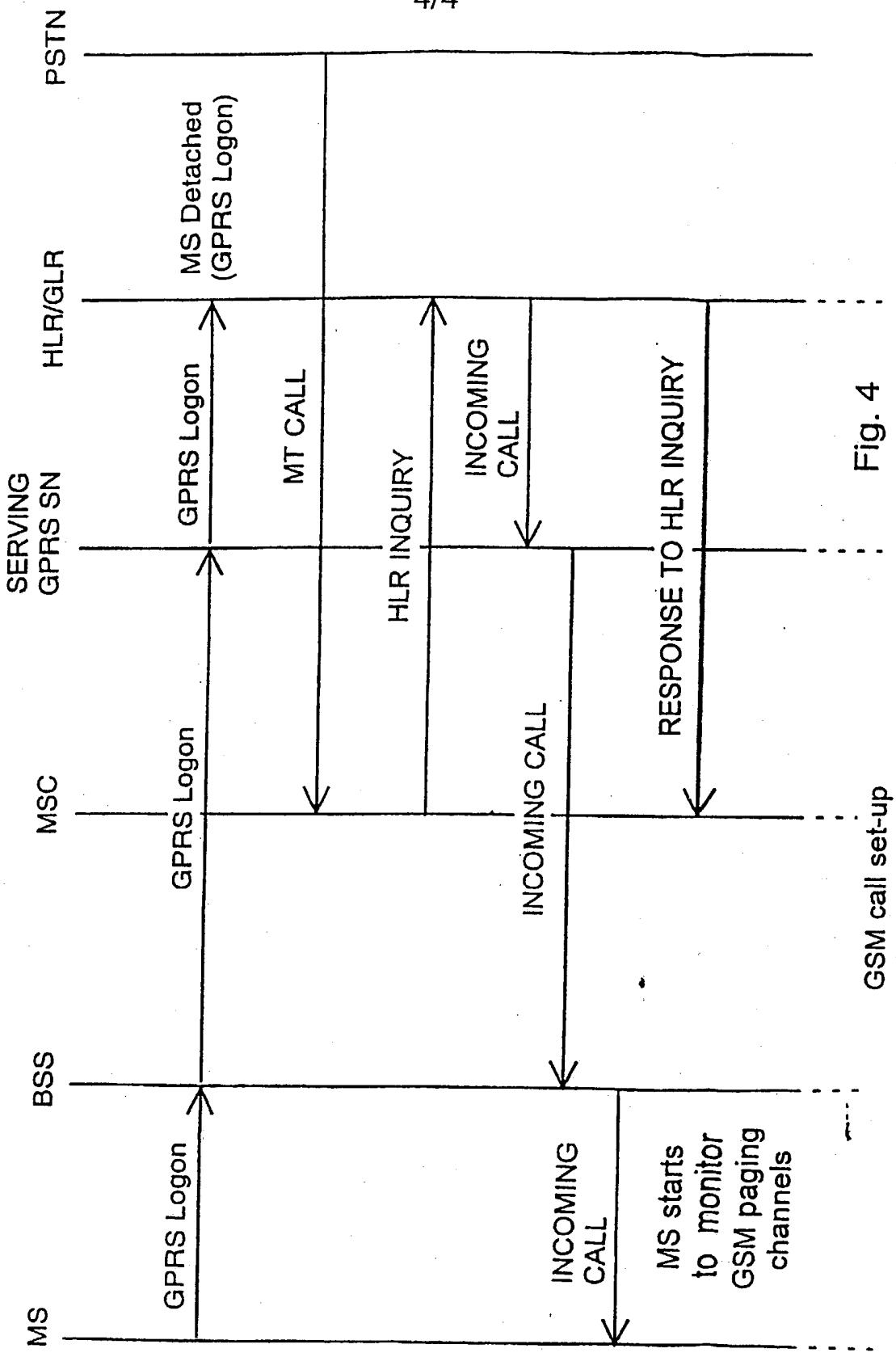
PSTN
HLR/GLR
SERVING GPRS SN
MSC
BSS
MS
MS Detached (GPRS Logon)
GPRS Logon
MT CALL
HLR INQUIRY
INCOMING CALL
RESPONSE TO HLR INQUIRY
GPRS Logon
INCOMING CALL
GPRS Logon
INCOMING CALL
MS starts to monitor GSM paging channels
GSM call set-up

Fig. 4

INTERNATIONAL SEARCH REPORT

International application No.
PCT/FI 97/00020

A. CLASSIFICATION OF SUBJECT MATTER

IPC6: H04Q 7/22, H04L 12/56
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC6: H04Q

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

SE,DK,FI,NO classes as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	EP, 0642283, A2 (NOKIA MOBILE PHONES LTD.) 8 Mar 1995, (08.03.95); abstract; figs. 4-7, fig. 15; p. 2, l. 46 - p. 3, l. 21; p. 4, ll. 21-37; p. 4, ll. 50-53; p. 5, ll. 13-30; p. 5, ll. 39-40; p. 6, ll. 34-35; p. 9, ll. 31-35;	1-6,8
Y	--	7,9-16

[X] Further documents are listed in the continuation of Box C. [X] See patent family annex.

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"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
19 June 1997	25 -06- 1997
Name and mailing address of the ISA/ Swedish Patent Office Box 5055, S-102 42 STOCKHOLM Facsimile No. +46 8 666 02 86	Authorized officer Per Källquist Telephone No. +46 8 782 25 00

INTERNATIONAL SEARCH REPORT

International application No.
PCT/FI 97/00020

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	IEEE Transactions on Vehicular Technology, vol 42, no. 1, Feb 1993, New York, US, pp. 1-13. N.M. Mitrou et al.: 'Voice and Data Integration in the Air-Interface of a Microcellular Mobile Communication System' p. 2, left col., ll. 18-24; p. 2, right col., ll. 26-32; p. 5, left col., ll. 13-21, ll. 36-41; p. 6, left col., ll. 10-25; p. 6, right col., l. 20- p. 7, left col., l. 9	7,9-16
A	WO, 9516330, A1 (TELEFONAKTIEBOLAGET LM ERICSSON) 15 June 1995, (15.06.95); abstract; p. 3, l. 25 - p. 4, l. 9; p. 16, ll. 3-6; p. 18, ll. 3-14, ll. 32-34; p. 20, ll. 19-30; claims 50-51	1-16
A	US 4887265 A (K.A. FELIX), 12 December 1989 (12.12.89), figures 1,5, abstract	1-16
A	WO 9520283 A1 (NOKIA TELECOMMUNICATIONS OY ET AL), 27 July 1995 (27.07.95), page 8, line 13 - line 21; page 18, line 8 - line 18, abstract	1-16
A	WO 9528063 A2 (NOKIA TELECOMMUNICATIONS OY), 19 October 1995 (19.10.95), page 8, line 20 - line 23; page 12, line 12 - line 20; page 20, line 5 - line 15, abstract	1-16

INTERNATIONAL SEARCH REPORT

International application No.
PCT/FI 97/00020

I: The invention as claimed in claims 1-11 and 14-16 refers to that the subscriber database has information on that the mobile terminal equipment is not available for calls, when the moblie terminal equipment is in packet mode.

II: The invention as claimed in claims 12 and 13 refers to that the subscriber database has information on that the availability for calls of the mobile terminal equipment is uncertain, when the moblie terminal equipment is in packet mode.

These groups of inventions are not so linked as to form a single general inventive concept (PCT Rule 13.1). There is no technical relationship among those inventions involving one or more of the same or corresponding technical features within the meaning of PCT Rule 13.2.

INTERNATIONAL SEARCH REPORT

International application No.
PCT/FI 97/00020

Box I Observations where certain claims were found unsearchable (Continuation of item 1 of first sheet)

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:

2. ☐ Claims Nos.:
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:

3. ☐ Claims Nos.:
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box II Observations where unity of invention is lacking (Continuation of item 2 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

See extra sheet.

1. ☐ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.

2. ☒ As all searchable claims could be searched without effort justifying an additional fee, this Authority did not invite payment of any additional fee.

3. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:

4. ☐ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

Remark on Protest

☐ The additional search fees were accompanied by the applicant's protest.

☐ No protest accompanied the payment of additional search fees.

INTERNATIONAL SEARCH REPORT

Information on patent family members

03/06/97

International application No.
PCT/FI 97/00020

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
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		SE 0332818 T3	
		EP 0746172 A	04/12/96
		ES 2095829 T	01/03/97
		JP 1274524 A	02/11/89
		JP 7105975 B	13/11/95
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		CN 1138929 A	25/12/96
		EP 0740876 A	06/11/96
		FI 94700 B,C	30/06/95
		FI 940314 D	00/00/00
WO 9528063 A2	19/10/95	AU 2778795 A	30/10/95
		CN 1145156 A	12/03/97
		EP 0754395 A	22/01/97
		FI 95984 B,C	29/12/95
		FI 941652 A	09/10/95

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INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification 6 : H04L 12/56, H04Q 7/22 — A1

(11) International Publication Number: **WO 99/05828**

(43) International Publication Date: 4 February 1999 (04.02.99)

(21) International Application Number: PCT/SE98/01385

(22) International Filing Date: 14 July 1998 (14.07.98)

(30) Priority Data:
60/054,469 25 July 1997 (25.07.97) US
09/087,496 29 May 1998 (29.05.98) US

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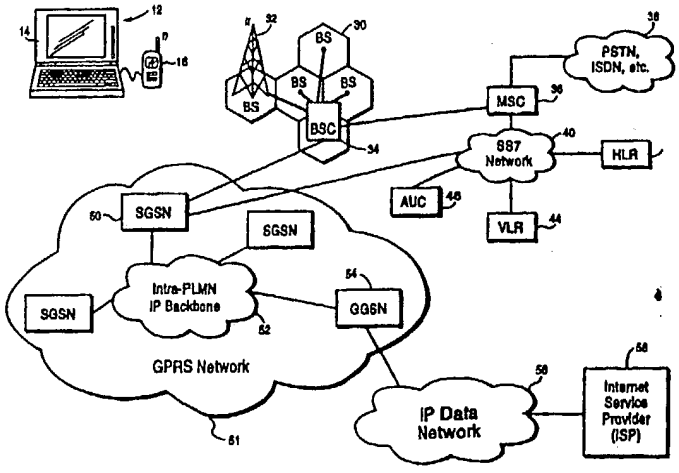
(74) Agent: ERICSSON RADIO SYSTEMS AB; Common Patent Dept., S-164 80 Stockholm (SE).

(81) Designated States: AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, CA, CH, CN, CU, CZ, DE, DK, EE, ES, FI, GB, GE, GH, GM, HR, HU, ID, IL, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MD, MG, MK, MN, MW, MX, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL, TJ, TM, TR, TT, UA, UG, UZ, VN, YU, ZW, ARIPO patent (GH, GM, KE, LS, MW, SD, SZ, UG, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GW, ML, MR, NE, SN, TD, TG).

Published
With international search report.
Before the expiration of the time limit for amending the claims and to be republished in the event of the receipt of amendments.

(54) Title: DYNAMIC QUALITY OF SERVICE RESERVATION IN A MOBILE COMMUNICATIONS NETWORK



(57) Abstract

In a mobile communications system (10), a mobile host (12) communicates packet data with an external network (56) by way of a packet gateway node (54). The mobile host establishes a packet session during which plural application flows are communicated with an external network entity. Each application flow includes a corresponding stream of packets. In addition, a corresponding quality of service parameter is defined and reserved for each of the plural application flows. In this way, different quality of service parameters may be defined and reserved for different ones of the application flows. Packets corresponding to each of the application flows are then delivered, for example, from the external network entity all the way to the mobile host in accordance with the quality of service reserved for that application flow. Different qualities of service may have different allocated bandwidths, delays, and/or reliabilities.

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DYNAMIC QUALITY OF SERVICE RESERVATION IN A MOBILE COMMUNICATIONS NETWORK

RELATED APPLICATION

This application claims priority from U.S. Provisional Patent Application Serial No. 60/054,469, filed July 25, 1997.

FIELD OF THE INVENTION

The present invention relates to mobile communications, and more particularly, to the reservation of a particular class or quality of service for individual mobile communications.

BACKGROUND AND SUMMARY OF THE INVENTION

The main application of most mobile radio systems like the Global System for Mobile communications (GSM) has been mobile telephony. However, the use of mobile data applications like facsimile transmission and short message exchange is becoming more popular. New data applications include wireless personal computers, mobile offices, electronic funds transfer, road transport telemetry, field service businesses, fleet management, etc. These applications are characterized by "bursty" traffic. In other words, a relatively large amount of data is transmitted over a relatively short time interval followed by significant time intervals when little or no data is transmitted.

In bursty traffic situations, packet-switched communications mechanisms better utilize the transmission medium than circuit-switched mechanisms. In a packet-switched network, the transmission medium is used only on demand, and a single physical channel can be shared by many users. Another advantage is that in contrast to

time-oriented charging applied for circuit-switched connections, packet-switched data services allow charging depending on the amount of data transmission and on the quality of service of that transmission.

In order to accommodate these new mobile applications, packet radio services, like the General Packet Radio Service (GPRS) incorporated in GSM, accommodate connectionless, packet-switched data services with high bandwidth efficiency. Cellular Digital Packet Data (CDPD) networks are another example. A significant interest of end users of a mobile packet data service such as GPRS is that wireless PCs support conventional Internet-based applications like file transfer, submission and reception of e-mail, and "surfing" the Internet via the worldwide web. Video is also a possible important element of multimedia services that may ultimately be supported by GPRS-type services.

Fig. 1 shows a mobile data service from a user's point of view in the context of a mobile communications system 10. An end user communicates data packets using a mobile host 12 including for example a laptop computer 14 connected to a mobile terminal 16. The mobile host 12 communicates for example with a fixed computer terminal 18 incorporated in a local area network (LAN) 20 through a mobile packet data support node 22 via one or more routers 24, a packet data network 26, and a router 28 in the local area network 20. Of course, those skilled in the art will appreciate that this drawing is simplified in that the "path" is a logical path rather than an actual physical path or connection. In a connectionless data packet communication between the mobile host 12 and fixed terminal 18, packets are routed from the source to the destination independently and do not necessarily follow the same path (although they can).

Thus, independent packet routing and transfer within the mobile network is supported by a mobile packet data support node 22 which acts as a logical interface or gateway to external packet networks. A subscriber may send and receive data in an

end-to-end packet transfer mode without using any network resources in a circuit-switched mode. Moreover, multiple point-to-point, parallel sessions are possible. For example, a mobile host like a mobile PC might run several applications at one time like a video conference, an e-mail communication, or facsimile web browsing, etc.

Fig. 2 shows a more detailed mobile communications system using the example GSM mobile communications model that supports both circuit-switched and packet-switched communications. A mobile host 12 including a computer terminal 14 and mobile radio 16 communicates over a radio interface with one or more base stations (BSs) 32. Each base station 32 is located in a corresponding cell 30. Multiple base stations 32 are connected to a base station controller (BSC) 34 which manages the allocation and deallocation of radio resources and controls handovers of mobile stations from one base station to another. A base station controller and its associated base stations are sometimes referred to as a base station subsystem (BSS). The BSC 34 is connected to a mobile switching center (MSC) 36 through which circuit-switched connections are set up with other networks 38 such as the Public Switched Telephone Network (PSTN), Integrated Services Digital Network (ISDN), etc.

The MSC 36 is also connected via a Signaling System Number 7 (SS7) network 40 to a Home Location Register (HLR) 42, a Visitor Location Register (VLR) 44, and Authentication Center (AuC) 46. The VLR 44 includes a database containing the information about all mobile stations currently located in a corresponding location or service area as well as temporary subscriber information needed by the MSC to provide services to mobiles in its service area. Typically, when a mobile station enters a visiting network or service area, the corresponding VLR 44 requests and receives data about the roaming mobile station from the mobile's HLR and stores it. As a result, when the visiting mobile station is involved in a call, the VLR 44 already has the information needed for call setup.

"attach" to the GPRS network 51 to make its presence known and to create a packet data protocol (PDP) context to establish a relationship with a gateway GGSN 54 towards the external network that the mobile host is accessing. The attach procedure is carried out between the mobile host 12 and the SGSN 50 to establish a logical link. As a result, a temporary logical link identity is assigned to the mobile host 12. A PDP context is established between the mobile host and the GGSN 54. The selection of GGSN 54 is based on the name of the external network to be reached. One or more application flows (sometimes called "routing contexts") may be established for a single PDP context through negotiations with the GGSN 54. An application flow corresponds to a stream of data packets distinguishable as being associated with a particular host application. An example application flow is an electronic mail message from the mobile host to a fixed terminal. Another example application flow is a link to a particular Internet Service Provider (ISP) to download a graphics file from a web site. Both of these application flows are associated with the same mobile host and the same PDP context.

Connectionless data communications are based on specific protocol procedures, which are typically separated into different layers. Fig. 3 shows a GPRS "transmission plane" that is modeled with multi-layer protocol stacks. Between the GGSN and the SGSN, the GPRS tunneling protocol (GTP) tunnels the PDUs through the GPRS backbone network 52 by adding routing information. The GTP header contains a tunnel end point identifier for point-to-point and multicast packets as well as a group identity for point-to-multipoint packets. Additionally, a type field that specifies the PDU type and a quality of service profile associated with a PDP context session are included. Below the GTP, the well-known Transmission Control Protocol/User Diagram Protocol (TCP/UDP) and Internet Protocol (IP) are used as the GPRS backbone network layer protocols. Ethernet, frame relay (FR), or asynchronous transfer mode (ATM)-based protocols may be used for the link and physical layers depending on the operator's network architecture.

Between the SGSN and mobile station/host, a SubNetwork Dependent Convergence Protocol (SNDCP) maps network level protocol characteristics onto the underlying logical link control (LLC) and provides functionalities like multiplexing of network layer messages onto a single virtual logical connection, ciphering, segmentation, and compression. A Base Station System GPRS Protocol (BSSGP) is a flow control protocol, which allows the base station system to start and stop PDUs sent by the SGSN. This ensures that the BSS is not flooded by packets in case the radio link capacity is reduced, e.g., because of fading and other adverse conditions. Routing and quality of service information are also conveyed. Frame relay and ATM may be used to relay frames of PDUs over the physical layer.

Radio communication between the mobile station and the GPRS network covers physical and data link layer functionality. The physical layer is split up into a physical link sublayer (PLL) and a physical RF sublayer (RFL). RFL performs modulation and demodulation of the physical waveforms and specifies carrier frequencies, radio channel structures, and raw channel data rates. PLL provides services for information transfer over the physical radio channel and includes data unit framing, data coding, and detection/correction of physical medium transmission areas. The data link layer is separated into two distinct sublayers. The radio link control/medium access control (RLC/MAC) sublayer arbitrates access to the shared physical radio medium between multiple mobile stations and the GPRS network. RLC/MAC multiplexes data and signaling information, performs contention resolution, quality service control, and error handling. The logical link control (LLC) layer operates above the MAC layer and provides a logical link between the mobile host and the SGSN.

Quality of service corresponds to the goodness (quality) with which a certain operation (service) is performed. Certain services like multimedia applications or a simple phone call need guarantees about accuracy, dependability, and speed of transmission. Typically, in data communications, "best efforts" are employed, and no

special attention is paid to delay or throughput guarantees. Generally, quality of service parameters can be characterized qualitatively in three services classes including deterministic (used for hard, real-time application), statistical (used for soft real-time applications), and best effort (everything else where no guarantees are made). Quantitative parameters may include throughput (such as the average data rate or peak data rate), reliability, delay, and jitter corresponding to the variation delay between a minimum and maximum delay time that a message experiences.

In the context of providing quality of service (QoS) in a mobile data communications systems, one QoS approach is to assign a specific priority to each PDP context. But this approach is unsatisfactory. As defined above, each PDP context may have plural application flows. Each application flow in a current PDP context/session likely has different per packet delays needs. For example, real time applications like telephony require a guaranteed service while image video needs a predicted delay service. More specifically, elastic applications like interactive bursts, interactive bulk transfer, and asynchronous bulk transfer require different degrees of as soon as possible (or best effort) delay service.

Rather than limiting the quality of service to a single PDP context/single network level IP address, the present invention defines a quality of service for each individual application flow. An appropriate quality of service is separately reserved, monitored, and regulated for each application flow in a PDP context. Moreover, the present invention provides a dynamic quality of service reservation mechanism per PDP context which is introduced into a mobile data communications system in order to function as a quality of service "aware" client network layer that permits integration with other data service architectures such as the Internet to permit an end-to-end integrated service where quality of service can be specified from the mobile host all the way to a fixed host in an end-to-end communication.

A mobile communication system is provided where a mobile host communicates packet data with an external network by way of a packet gateway node. The mobile host establishes a packet session during which plural application flows are communicated with an external network entity. Each application flow includes a corresponding stream of packets. In addition, a corresponding quality of service parameter is defined and reserved for each of the plural application flows. In this way, different quality of service parameters may be defined and reserved for different ones of the application flows. Packets corresponding to each of the application flows are then delivered, for example, from the external network entity all the way to the mobile host in accordance with the quality of service reserved for that application flow.

Different qualities of service may have different allocated bandwidths, delays, and/or reliabilities. One class of service is best effort where packets in an application flow may be dropped. Other classes of service are classified as predictive where packets in an application flow are not dropped. In terms of delay, quality of service may include delay classes that specify a maximum packet transfer rate, a mean packet transfer rate, and a packet burst size of an individual application flow.

Data services subscription information is stored for each mobile host and specifies whether the mobile host subscribes to a static or dynamic quality of service. If a dynamic quality of service is subscribed to where QoS may be specified for each application flow, the subscription information for such a mobile host defines specifically subscribed to quality of service parameters or classes. Then when the mobile host establishes a packet session, each subscribed quality of service class is made available for application flows which are activated during that session.

The process of establishing a packet session includes the mobile host "attaching" to the network (or other equivalent operation) and communicating a packet session start/activate message to the gateway node. Moreover, an end-to-end configuration procedure is established between the mobile terminal and the external

network entity at the other end. That end-to-end configuration assigns a network packet layer address to the mobile host. Several end-to-end configurations may exist on the same PDP context, and several application flows may exist using the same configuration. As a result, plural application flows may be flexibly established during the mobile host session having different network layer (e.g., IP) addresses and different qualities of service. In the configuration procedure, the gateway node functions as a dynamic host configuration agent serving the client mobile host relaying packets between the mobile host and the external network entity.

In addition to the data communications "tunnel" corresponding to the network layer bearer between the gateway node and the mobile host, a relationship is also established in the gateway node between a mobile host identifier (e.g., the mobile's IMSI), the established data communications tunnel, and the network layer address stored for the mobile host for the established session. Using this relationship, the gateway node analyzes received packets and only permits those packets having a destination or source corresponding to one of the mobile host network layer addresses stored for the established session.

After making a reservation request for a particular quality of service for an individual application flow, a determination is made whether the reservation request can be met under current traffic conditions. If the reservation request can be met, the network packet layer bearer between the mobile host and the gateway node is established to "bear" plural ones of the individual application flows having different corresponding quality of service classes.

In addition to the packet gateway node, a packet serving node is provided between the packet gateway node and the mobile host. Among other things, the serving node determines if the reservation request for the particular quality of service can be supported from the serving node to the mobile host based on a current traffic load of existing radio communications in the area where the mobile host is currently being

served. In particular, the serving node estimates delay and bandwidth requirements corresponding to the requested quality of service and provides them to the gateway node. Once an application flow reservation is made for a particular quality of service, the gateway node monitors that application flow to ensure that the reserved quality of service is met using appropriate packet classifying and transfer scheduling procedures.

For packets destined for mobile hosts, the serving node merges those packets from different sessions corresponding to the same mobile hosts which have the same quality of service. The serving node also merges packets destined for different mobile hosts located in the same geographical service area that have the same quality of service. Packets destined for the same geographical service area but having different qualities of service are assigned to different priority queues that correspond to those different qualities of service and are forwarded to the particular radio access network within the geographical area.

BRIEF DESCRIPTION OF THE DRAWINGS

The foregoing and other objects, features, and advantages of the invention will be apparent from the following description of preferred embodiments as illustrated in the accompanying drawings in which reference characters refer to the same parts throughout the various views. The drawings are not necessarily to scale with emphasis being placed upon illustrating the principles of the invention.

Fig. 1 is a simplified diagram showing a data communications between a mobile host and a fixed host;

Fig. 2 is a more detailed diagram showing a GSM mobile communications system including a General Packet Radio Service (GPRS) data network;

Fig. 3 illustrates various data communication protocols employed between different nodes in the GPRS data communications network shown in Fig. 2;

Fig. 4 is a flowchart diagram illustrating dynamic quality of service procedures in accordance with one embodiment of the present invention;

Fig. 5 is a flowchart diagram depicting illustrating dynamic quality of service procedures in GPRS in accordance with another example embodiment of the present invention;

Fig. 6 is a signaling sequence for PDP context activation in accordance with a detailed example GPRS embodiment of the present invention;

Fig. 7 is a signaling sequence for a network layer host configuration in accordance with the detailed GPRS example embodiment of the present invention;

Fig. 8 is a diagram depicting an established GPRS bearer between a gateway data node and a mobile host showing reservation of quality of service for a particular application flow;

Fig. 9 is a graph illustrating delay probability definitions for a GPRS bearer;

Figs. 10A and 10B show a message sequence showing dynamic quality of service reservation procedures in accordance with the detailed GPRS example embodiment of the present invention;

Fig. 11 is a diagram illustrating example queues and merging techniques that may be employed in serving nodes in accordance with packet classifying and scheduling procedures in the detailed example GPRS embodiment of the present invention;

Fig. 12 is a message sequence showing forwarding of packets at the network packet layer to the mobile host from an Internet service provider (ISP) in accordance with the detailed GPRS example embodiment of the present invention;

Fig. 13 is a function block diagram illustrating various example control functionalities in the mobile host and gateway node that may be used in implementing the present invention; and

Fig. 14 is a function block diagram illustrating various control functionalities in the serving data node and the gateway node that may be used in implementing the present invention.

DETAILED DESCRIPTION OF THE DRAWINGS

In the following description, for purposes of explanation and not limitation, specific details are set forth, such as particular embodiments, hardware, techniques, etc. in order to provide a thorough understanding of the invention. However, it will be apparent to one skilled in the art that the present invention may be practiced in other embodiments that depart from these specific details. For example, while a specific embodiment of the present invention is described in the context of a GSM/GPRS cellular telephone network, those skilled in the art will appreciate that the present invention can be implemented in any mobile communications system using other mobile data communications architectures and/or protocols. In other instances, detailed descriptions of well-known methods, interfaces, devices, and signaling techniques are omitted so as not to obscure the description of the present invention with unnecessary detail.

As described above, the present invention provides considerable flexibility and a wide range of data services to mobile subscribers by permitting definition and reservation of a specific quality of service for each of plural application

flows activated during a data session rather than restricting all application flows to a single quality of service assigned to the session. Referring to Fig. 4 which illustrates a dynamic quality of service routine (block 100), in accordance with a first embodiment of the present invention, a packet session is established for each mobile host. During that established packet session, plural application flows/packet streams are communicated between an external network entity like the fixed terminal 18 shown in Fig. 1 or an Internet service provider (ISP) shown in Fig. 2, and the mobile host such as the mobile host 12 shown in Figs. 1 and 2 (block 102). A quality of service (QoS) is reserved (if available given current traffic conditions) for each application flow during the established packet session, and notably, the quality of service for different application flows may differ (block 104). Packets corresponding to each application flow are delivered between the external network entity and the mobile host in accordance with the reserved corresponding quality of service (block 106). The established packet session may, thus, serve as a bearer for plural serial application sessions without requiring reestablishment and reconfiguration of the mobile host. The established packet session may also serve as a bearer for plural streams in one multimedia session while still adhering to individual quality of service requirements of voice, video, and data streams.

While the present invention may be advantageously applied to any mobile data communications network, a detailed example embodiment is now described in the context of the General Packet Radio Service (GPRS) employed in the well known GSM mobile radio communications network. Fig. 5 illustrates in flowchart format general procedures for providing a dynamic quality of service in GPRS in this detailed example embodiment (block 110). The first set of procedures relate to PDP context activation (block 112), where PDP means Packet Data Protocol corresponding to the network layer protocol used in the data communications system. Another way of describing a PDP context is that the mobile host has "logged-on" and started a data session with GPRS. In GPRS, there are two example PDPs that may be used including Internet

Protocol (IP) v4 and X.25. IP is assumed for purposes of the following example. The HLR 42 in Fig. 2 stores PDP contexts for each mobile subscriber in corresponding subscription records. The PDP subscription record includes subscribed quality of service profiles/parameters, subscribed external networks, etc. When a mobile system "attaches" to the GPRS network, the mobile host's subscription is retrieved from the HLR 42. As a result of PDP context activation, a network layer "bearer" or tunnel is established between the mobile host and the gateway GPRS support node (GGSN) 54.

After the PDP context activation, a network layer, e.g., IP, host configuration operation is performed to establish a network layer (IP) bearer communication between the mobile host 12 and an Internet Service Provider (ISP) 58 (block 114). The IP configuration includes assigning a network layer (IP) address to the mobile host, setting default values for a World Wide Web (WWW) server, a domain name server (DNS), an address resolution protocol (ARP) cache, etc. The IP bearer between the mobile host and the GGSN established in PDP context activation is now extended from the GGSN to the ISP. Packets can be routed back and forth between the mobile host and end-systems at the ISP.

The next step is dynamic quality of service reservation (block 116) in which a specific quality of service is reserved for each application flow established during the activated PDP context/data session (block 116). A number of procedures are performed (described below) to ensure that there is sufficient capacity for the requested QoS reservation and that the requesting mobile host is authorized to request reservation of the particular quality of service.

The final step relates to the forwarding of IP data packets between the external host such as the ISP 58 and the mobile host 12 (block 118). Such IP packet forwarding includes packet classifying, scheduling/queuing, and policing procedures (block 118). Detailed procedures for each of blocks 112-118 are now described in turn below.

Fig. 6 illustrates a signaling sequence for PDP context activation. Each vertical line in Fig. 6 represents a node illustrated in Fig. 2 including the mobile host (host/MS) 12, the SGSN 50, the GGSN 54, and the Internet Service Provider (ISP) 58. The mobile host sends an "activate PDP context request" message to the SGSN which includes an access point name (APN), i.e., the name of the ISP, a PDP type which in this example is IP, a Quality of Service (QoS) definition for this PDP context request itself which in this example is QoS class 4 Best Efforts (BE), and an end-to-end configuration request. Rather than requesting an IP address, the mobile host sends the end-to-end configuration request parameter to request a dynamic PDP address allocation after the PDP context has been established.

Upon receiving the activate PDP context request message from the mobile host, the SGSN checks the mobile's subscription in the HLR to determine whether the mobile host subscribes to a static or dynamic quality of service reservation. In static QoS reservation, all application flows receive the QoS established for the PDP context/data session. In dynamic QoS reservation, a QoS may be specified for individual application flows. A dynamic quality of service reservation subscription is assumed in this example. The access point name is translated to a GGSN address using the domain name system (DNS), i.e., the on-line distributed database system used to map human-readable machine names into IP addresses. In addition, a tunnel identifier (TID) is created for purposes of establishing a tunnel bearer between the GGSN and the mobile host. The SGSN sends to the GGSN a "create PDP context request" message along with the APN, PDP type, quality of service, TID, and end-to-end configuration request.

The GGSN functions as a dynamic host configuration protocol (DHCP) relay agent. DHCP is a protocol for allocating Internet protocol addresses to users. The allocation of the IP address is performed by a DHCP server, which in this example is the ISP 58, and the mobile host is the DHCP client. The GGSN also performs translation of the access point name to the ISP address via the domain name system, and

allocates a DHCP relay to the PDP request. Again, no IP address is yet allocated to the mobile host. The GGSN sends a "create PDP context response" message back to the SGSN which includes the tunnel identifier (TID) and an end-to-end configuration confirmation using a best efforts quality of service. The GGSN, functioning as the DHCP relay, selects a predefined tunnel or bearer for the selected access point name. The SGSN then sends an "activate PDP context accept" message to the mobile host. At this point, the logical tunnel/bearer is essentially open for packet traffic between the mobile host and the ISP, but only as IP broadcast messages because the mobile host is not addressable on network (IP) layer. Application flows transmitted via that logical link may have any one of the subscribed to quality of service parameters/classes.

The IP host configuration procedures are now described in conjunction with the signaling sequence shown in Fig. 7. The IP host configuration is transparent to the GPRS bearer set up in the PDP context activation procedures described above except for the inclusion of a DHCP relay agent in the GGSN. In the IP host configuration, the mobile host sends/broadcast a user datagram protocol (UDP) message (a transport layer protocol on top of IP) to the GGSN/DHCP relay which relays those UDP packets to the ISP. The UDP message includes a Dynamic Host Configuration Protocol (DHCP) DISCOVER message with an authentication token, IP address lease time request, and a host ID. The GGSN allocates an agent remote ID corresponding to the mobile's unique IMSI identifier and an agent circuit ID corresponding to the tunnel identifier. The GGSN later uses the agent circuit ID to filter out and stop packets from/to the mobile host that do not have the correct IP address in the header. The agent remote ID and a subnet mask are sent to the ISP where the agent remote ID (IMSI) is stored.

The subnet mask is an aggregate description of individual destinations on an IP subnet. An IP subnet is hosted by one router. The GGSN is a router, and thus, aggregates one or more subnets. The ISP uses the subnet information to route the response back to the GGSN, which in turn, forwards the response to the correct mobile

host based on the agent remote ID. The agent remote ID also gives the ISP additional insurance that the mobile host is not faking its identify during the dynamic host configuration procedures. The GGSN may either be configured to relay the DHCP DISCOVER message to a certain DHCP server or broadcast it to the ISP network. A DHCP OFFER message is forwarded from the ISP to the mobile host including the "offered" configurations that the DHCP server can provide. Multiple offers can be received from various DHCP servers. The mobile host selects the DHCP offer that best satisfies its requirements and sends a DHCP request message to the DHCP server which provided that selected offer.

The ISP then provides an IP address to the GGSN in a DHCP acknowledgment message. The IP address is placed in a table along with the mobile's agent remote ID/IMSI and agent circuit ID/tunnel identifier for later usage in the packet filter. The GGSN also relays the DHCP acknowledgment message to the mobile host. The IP address and the agent circuit ID are used to filter all packets to/from the mobile host that do not have the correct IP address in the packet header.

A quality of service for each user application flow activated in the PDP context is next reserved. Fig. 8 shows a diagram depicting a quality of service reservation for an application flow coming from the ISP and terminating at the mobile terminal. The GGSN 54 forwards a reserve path message to the mobile host 12 over a GPRS bearer which was established in the PDP context activation for a particular application flow directed to the mobile host 12. The mobile host then returns a reservation response to the GGSN 54. In this example, a resource reservation protocol (RSVP) is employed to permit a mobile host to request a certain quality of service for a transmission from an Internet user at an ISP. RSVP uses source and destination IP addresses as well as a UDP/TCP port to identify the application flows to be reserved. A destination IP address may have several ports, related to each application process in the system. Well-known ports are defined for several types of applications. The end

systems may also negotiate to select a port other than the well-known ports. All packets that belong to the same application flow share the same identifier (address and port).

RSVP sets a temporary or "soft" reservation in each router along the path between the sender and receiver. A soft reservation has a Time To Live (TTL) associated with it. If the time to live expires, then the reservation also expires. A best effort quality of service is used to transfer the RSVP messages over the GPRS bearer.

The GGSN, acting as a router, needs to ensure that it can commit to the requested QoS reservation for its logical link towards the mobile host. As a result, the GGSN maps the requirements from the IP RSVP request to the reservation for the GPRS logical link. The first part of the GPRS logical link is the GPRS tunneling protocol (GTP) to the SGSN. GTP is carried on IP, and thus, a change of reservation for this internal IP network may be needed if the current reservation cannot handle an additional application flow. The GGSN also asks the SGSN to check the latter part of the logical link towards the mobile host. This latter part of the logical link has two "hops" -- SGSN-to-BSS and BSS-to-mobile host. The SGSN controls the reservation in both hops and indicates to the GGSN whether the change in reservation for the QoS class in the PDP context is acceptable. The GGSN provides the QoS information on packet delay and bandwidth for the application flow to the next router on the chain.

The first parameter is a link dependent delay that can be divided into a rate independent part (C) and a rate dependent part (D) part. The required delay of the end-to-end path between the mobile host and the end system at the ISP can be calculated as the sum of:

$$D_{req} = S + (b / R) + C_{tot} / R + D_{tot},$$

where D_{req} = the implicit total delay required by the mobile host, S = a slack term between a desired and a reserved delay, b = a buffer bucket depth measured in bytes, R

= a negotiated mean bit rate (e.g., IP datagrams per second), C_{tot} is a sum of rate independent deviations from a fluid model, and D_{tot} is the sum of rate dependent deviations from a "fluid model." The fluid model defines transport through the network if there is no packet buffering, i.e., no packeting queuing, at any node.

With this information, the delay probability distribution for the GPRS bearer may be plotted based on a mean Packet Transfer Delay (PTD), a maximum packet transfer delay, and the delay deviation parameters compared to the fluid model consisting of the rate independent (C) and rate dependent (D) parts of the link dependent delay. The graph in Fig. 9 shows the probability density graphed against the delay for these variables. The bucket depth b defines the number of bytes that a node is required to allocate to a flow in its buffer. The node does not police packets until the bucket depth b is reached. This is part of the QoS agreement. The bucket depth b is used to determine maximum buffering requirements for an application flow B for a particular QoS. The required buffer size is defined as follows:

$$B > b + C_{sum} + D_{sum} * R,$$

where C_{sum} and D_{sum} are the sum of individual routers C and D. The routers include GGSN and other routers on the path between the mobile host and the end system at the ISP. The GGSN installs the bucket depth b for the QoS reservation.

An example message sequence is now provided for a dynamic quality of service reservation for an individual application flow from the ISP terminating at the mobile host as shown in Figs. 10A and 10B. The end system at the ISP sends a path reservation message including the session ID assigned to the flow. The GGSN forwards the RSVP path message to the mobile host using a best efforts GPRS quality of service. The path reservation message also includes a traffic specification (TSPEC). The TSPEC describes the characteristics of the application flow that the ISP end system is sending, e.g., rate and delay sensitivity.

The mobile host responds to the GGSN with a RSVP reservation (RESV) message. The RESV message includes a FLOWSPEC and a FILTERSPEC. The FLOWSPEC describes the rate and delay reservation that the mobile host is requesting for the flow. The FILTERSPEC defines in which ways the mobile host allows the network to merge the mobile host reservation with other receivers in a multicast environment. The GGSN applies policy and admission control to the reservation request. As part of the procedure, the GGSN maps the RSVP request to the GPRS GTP update PDP context request. The GTP update PDP context request is sent to the SGSN. The message relates to changing the bandwidth for the GPRS bearer for the particular mobile host, PDP context and QoS delay class to which the application flow belongs. The SGSN determines by checking the subscription corresponding to the mobile host in the HLR 42 whether the quality of service reservations may be made for the specific QoS delay class (referred to as POLICY CONTROL). The SGSN also determines whether there is sufficient capacity for the reservation for the "radio leg" (referred to as ADMISSION CONTROL). If the policy and admission controls are satisfied, the SGSN sends a GTP update PDP context response to the GGSN. The GGSN maps the GTP response to the RSVP request and changes the bandwidth reservation of the GPRS tunnel to the SGSN for the PDP context and QoS delay class, if necessary. Preferably, the reservation tunnel is overdimensioned, and therefore, a separate reservation change may not be required. The reservation tunnel preferably aggregates several mobile hosts and PDP contexts.

The SGSN estimates the requested quality of service delay by monitoring the time between link layer packet transmissions and acknowledgments. The estimates are used to evaluate if new reservations may be accepted without affecting existing reservations. The estimates are also used to provide the delay deviations compared to the fluid model that are need for RSVP. In addition, the BSS sends a BSSGP flow control message to the SGSN to inform the SGSN of the current traffic condition from the BSS to the mobile host and the availability of providing the requested quality of

service rate given those traffic conditions. If the rate within a geographical radio area is low, no new reservation may be made in SGSN. Preferably, the SGSN allocates at least twenty percent of available BSC/cell capacity to the best effort quality of service delay class to minimize packet loss for predicted delay flows in the GPRS bearer. The SGSN sends a BSSGP flow control acknowledgment to the BSS for a received window.

The data packet forwarding procedures include packet classifying, scheduling, and policing functions. In order to classify and schedule packets in an individual application flow based on the flow's reserved quality of service, various queues/buffers are employed in the BSS and the SGSN. An example configuration of queues in the BSS and SGSN is shown in Fig. 11. The BSS includes a queue for mobility management signaling at each base station cell as well as a queue for each of four quality of service delay classes QoS 1-QoS 4 at each base station cell. The SGSN includes three different levels of queues used to classify and merge packets. The first layer of queues is at the SNDCP protocol layer. One queue is established for packets having the same PDP context and quality of service delay class. The second queue layer includes one queue for packets corresponding to the same mobile host and quality of service delay class. The third queue layer includes a queue storing packets corresponding to the same cell and quality of service delay class. Small buffering in the BSS permits efficient utilization of the limited bandwidth radio channels since packets are always available for transmission. Large buffering in the SGSN minimizes the use of limited radio resources because packets may be discarded there before they are to be transmitted over the radio air interface and hooked into a logical link control transmission loop between the SGSN and the mobile host.

Preferably, a set of packet classification, scheduling, and policing (all of which involve buffer management) are performed. Based on different classifiers, the GGSN, SGSN, and BSS each perform such a set of packet functions. A number of known packet classification, scheduling, and policing algorithms may be used. In the preferred embodiment, the GGSN "polices," (i.e., checks that the flows are within

agreed limits and discards packets if not,) the RSVP application flows, classifies those application flows corresponding to their PDP context and quality of service delay class, and schedules forwarding of packets based on the tunnel protocol (GTP) reservation for the PDP context and quality of service delay class. The SGSN, on the other hand, classifies and schedules packets on a MS basis. The BSS preferably employs a first-in-first-out (FIFO) scheduling algorithm for frames of packets received with the same quality of service delay class and cell identifier. Prioritization of packet transfer scheduling between quality of service delay classes is also preferably controlled by the BSS with the BSS passing LLC frames having a higher quality of service delay class before transferring LLC frames having a lower quality of service delay class.

Reference is now made to Fig. 12 which shows an example message sequence for forwarding network layer packets to the mobile host from the ISP. The GGSN receives from the ISP an IP packet application flow destined for the mobile host. The GGSN performs bandwidth policing for each application flow using for example an RSVP leaky bucket algorithm or other PDP specific algorithm. The admissible incoming packets are then classified by PDP context/quality of service delay class. Those classified packets are scheduled for GTP transfer over the GPRS logical bearer established for the mobile host's PDP context based on the RSVP bandwidth reservation for that application flow. Using the tunneling protocol (GTP), the GGSN encapsulates the IP packet flow with the tunnel identifier and the reserved quality of service for that application flow. The encapsulated packet flow is received by the SGSN which performs bandwidth policing of the flow from a particular GGSN and quality of service delay class.

The SGSN also classifies the packets corresponding to mobile subscriber ID (MSID), PDP context, and quality of service delay class. Preferably, the SGSN uses a fair queuing (e.g., bit wise round robin) algorithm for packet scheduling at the SNDCP/LLC level to merge several PDP contexts of the mobile terminal with the same quality of service delay class. A weighted fair queuing (WFQ) algorithm may be used

for scheduling packet transfer at the BSSGP level using the tunnel bandwidth reservation data relating to each mobile terminal/quality of service delay class in order to merge LLC application flows of the same quality of service delay class from different mobile terminals in a single queue. The queued data is then transferred to the BSS, which classifies the incoming data by cell and quality of service delay class. As mentioned above, the BSS preferably uses a FIFO scheduling algorithm for each cell/quality of service delay class queue in addition to configurable values for priority queuing for different quality of service delay classes. The BSS then performs packet resource assignment at the RLC/MAC layers to transfer individual packets. The packets are generally divided into data blocks, and one radio data channel may be shared by several mobile terminals with each radio block having a separate identifier.

Figs. 13 and 14 display the components active within the mobile host, GGSN, and SGSN, respectively, during application flow reservation and packet forwarding from an end system at an ISP to a mobile host. All three systems have a control engine and a forwarding engine. The control engine is active during application flow reservation, while the forwarding engine is active during packet forwarding. The RSVP daemons in the mobile host and the GGSN are responsible for the resource reservation protocol exchange at the IP layer and communicate with each other using the RSVP protocol. The RSVP daemon checks with the policy controller to determine if the mobile host subscribes to the QoS. The RSVP daemon also checks with the admission controller if the forwarding system can accommodate another QoS reservation based on available resources.

The RSVP daemon instructs the packet classifier which parameter to use when separating incoming packets into different queues. The RSVP daemon instructs the packet scheduler which scheduling technique to use when merging queues towards the output ports of the system. In addition, the GGSN routing process decides to which output port a packet will be sent based on destination address, etc. The SGSN performs a similar function in its mobility management process which keeps track of the location

of the mobile host. The GTP daemon has the same responsibilities as the RSVP daemon but on the GPRS link layer between SGSN and GGSN. There is an application programming interface (API) between the RSVP daemon and the GTP daemon in the GGSN in order to request and give feedback on reservations coming from IP (RSVP) to link (GPRS) layer.

While the present invention has been described with respect to particular embodiments, those skilled in the art will recognize that the present invention is not limited to the specific embodiments described and illustrated herein. Different formats, embodiments, and adaptations besides those shown and described, as well as many variations, modifications, and equivalent arrangements may also be used to implement the invention. Therefore, while the present invention has been described in relation to its preferred embodiments, it is to be understood that this disclosure is only illustrative and exemplary of the present invention and is merely for the purposes of providing a full and enabling disclosure of the invention. Accordingly, it is intended that the invention be limited only by the spirit and scope of the claims appended hereto.

WHAT IS CLAIMED:

1. In a mobile communications system where a mobile host communicates packet data with an external network by way of a packet gateway node, a method comprising:

the mobile host establishing a packet session during which plural application flows are communicated with an external network entity, each application flow having a corresponding stream of packets, and

defining a corresponding quality of service parameter for each of the plural application flows such that different quality of service parameters may be defined for different ones of the application flows.

2. The method in claim 1, further comprising:

delivering packets corresponding to each application flow from the external network entity to the mobile host in accordance with the defined corresponding quality of service.

3. The method in claim 2, wherein the quality of service is defined for each application flow at a network packet layer for an end to end communication from the mobile host and the external network entity

4. The method in claim 1, wherein different qualities of service have different allocated bandwidths, delays, or reliability.

5. The method in claim 4, wherein the different quality of services include one class of service that is best effort where packets in an application flow may be dropped and another class of service that is predictive where packets in an application flow are not dropped.

6. The method in claim 1, wherein a quality of service includes a delay class that specifies one or more of the following: a maximum packet transfer rate, a mean packet transfer rate, and a packet burst size of an application flow.

7. The method in claim 1, further comprising:

storing subscription information for the mobile host specifying whether the mobile host may request a quality of service for specific application flows, and

checking the subscription information before defining quality of service parameters.

8. The method in claim 7, further comprising:

making available for the session each quality of service class to which a user of the mobile host subscribes.

9. The method in claim 1, wherein session control messages are communicated between the mobile host and the gateway node using a best efforts quality of service delay class.

10. The method in claim 1, wherein establishing the packet session includes:

activating a packet session for the mobile host so that the mobile host is in communication with the gateway node;

the mobile terminal requesting an end-to-end configuration between the mobile terminal and the external network entity.

11. The method in clam 10, wherein the end-to-end configuration request establishes a network packet layer bearer between the mobile host and the gateway node permitting relay of data packets between the external network entity and the mobile host even though a network packet layer address is not assigned to the mobile host.

12. The method in claim 11, wherein the gateway node functions as a dynamic host configuration agent serving the mobile host as a client relaying packets between the mobile host and the external network entity.

13. The method in claim 12, further comprising:

adding a remote agent identification corresponding to a mobile host identifier to messages intended for the external network entity.

14. The method in claim 13, wherein during configuration, the dynamic host configuration agent captures and stores a unique network packet layer address for the mobile host for the established session for each application flow activated during the established session.

15. The method in claim 14, further comprising:

establishing a data communications tunnel corresponding to the network layer bearer between the gateway node and the mobile host, and

establishing a relationship in the gateway node between a mobile host's identifier, the established tunnel, and the network packet layer address for the mobile host for the established session.

16. The method in claim 15, further comprising:

analyzing packets received at the gateway node and permitting only packets having a destination or source corresponding to one of the mobile host network layer addresses stored for the established session.

17. The method in claim 15, further comprising:

the gateway node routing packets according to a shortest path based on the network layer address for the mobile host for the established session.

18. In a mobile communications system where a mobile host communicates packet data with an external network by way of a packet gateway node and a packet serving node, a method comprising:

the mobile host establishing a packet session during which plural application flows are communicated with an external network entity, each application flow having a corresponding stream of packets;

making a reservation request from the mobile host to the gateway node for a particular quality of service for an individual application flow;

determining whether the reservation request can be met; and

if so, establishing a logical bearer between the mobile host and the gateway node that includes the serving node to bear plural ones of the individual application flows having different corresponding quality of service classes.

19. The method in claim 18, further comprising:

classifying and scheduling packets corresponding to each application flow from the external network to the mobile host over the bearer in accordance with the defined quality of service class corresponding to the application packet stream.

20. The method in claim 18, further comprising:

the serving node determining if the reservation request for the particular quality of service is permitted by a subscription corresponding to the mobile host.

21. The method in claim 18, further comprising:

the serving node evaluating if the reservation request for the particular quality of service can be supported from the serving node to the mobile host based on a current traffic load of existing radio communications in the area where the mobile host is being served.

22. The method in claim 21, wherein the evaluating step includes the serving node estimating a delay and a bandwidth requirement corresponding to the requested quality of service.

23. The method in claim 22, further comprising:

the serving node providing the gateway node the estimated delay and an estimate of a bandwidth requirement corresponding to the reservation request, and

the gateway node providing the delay and bandwidth estimates to a network layer protocol.

24. The method in claim 18, further comprising:

the gateway node renewing the quality of service reservation.

25. The method in claim 19, further comprising:

the gateway node monitoring each application flow to ensure that the reserved quality of service for that application flow is met.

26. The method in claim 19, further comprising:

the gateway node scheduling transfer of packets corresponding to one of the application flows to ensure that the reserved quality of service for that application flow is met.

27. The method in claim 19, further comprising:

the gateway node classifying packets using the reserved quality of service for the application flow to which each packet belongs.

28. The method in claim 19, further comprising:

the serving node monitoring each of the application flows from the gateway node to determine whether a data transmission volume limit is exceeded, and

if so, the serving node discarding packets corresponding to an application flow having a lowest quality of service reserved.

29. In a mobile communications system where mobile hosts communicate packet data with an external network by way of a packet gateway node and a packet serving node, a method comprising:

each mobile host establishing a packet session during which plural application flows are communicated with an external network entity, each application flow having a corresponding stream of packets;

defining a corresponding quality of service parameter for each of the plural application flows such that different quality of service parameters may be defined for different ones of the application flows; and

the serving node merging packets from different sessions with the same quality of service.

30. The method in claim 29, further comprising:

the serving node merging packets destined for different mobile hosts within a same geographical service area and with the same quality of service.

31. The method in claim 29, wherein the merging is performed using first in first out scheduling except when packets cannot be delivered within a specified time.

32. The method in claim 29, further comprising:

the serving node assigning packets destined for a same geographical service area but with different qualities of service to different priority queues corresponding to the different qualities of service,

wherein a larger number of packets are removed from a queue having a higher quality of service than a queue having a lower quality of service.

33. A mobile communications system, comprising:

a mobile terminal establishing a data packet communications session, running two data packet applications during the session, and communicating two data packet streams corresponding to the two data packet applications with another entity in an external network, and

a packet network connected between the mobile terminal and the external network entity reserving a different quality of service class for each of the two data packet streams associated with the mobile terminal during the session.

34. The mobile communications system in claim 33, wherein packets corresponding to the two data packet streams having different quality of service classes are transferred to and from the mobile terminal using a data packet network bearer established for the session.

35. The mobile communications system in claim 33, wherein the quality of service class is reserved for each of the two data packet streams at a network packet layer for an end to end communication from the mobile terminal and the external network entity.

36. The mobile communications system in claim 33, wherein different qualities of service classes have different allocated bandwidths, delays, or reliability.

37. The mobile communications system in claim 33, wherein one of the different quality of service classes is a best effort delivery class where packets in an application flow may be dropped and another class of service is a predictive delivery service where packets in an application flow are not dropped.

38. The mobile communications system in claim 33, wherein each quality of service class includes a delay class that specifies one or more of the following: a maximum packet transfer rate, a mean packet transfer rate, and a packet burst size of an application flow.

39. The mobile communications system in claim 33, further comprising:

a database node that stores subscription information for the mobile terminal specifying whether the mobile terminal may request a quality of service for specific application data packet streams,

wherein the packet node checks the subscription information before a quality of service class is reserved.

40. The mobile communications system in claim 33, wherein the packet network includes:

a serving node connected between the gateway node and the mobile terminal;

a gateway node connected between the serving node and the external network entity.

41. The mobile communications system in claim 40, wherein the gateway node relays packets between the mobile terminal and the external network entity.

42. The mobile communications system in claim 40, wherein the serving node evaluates if a quality of service class reservation request can be supported from the

serving node to the mobile terminal based on a current traffic load of existing radio communications in an area where the mobile terminal is being served.

43. The mobile communications system in claim 40, wherein the serving node estimates a delay and a bandwidth requirement corresponding to the requested quality of service.

44. The mobile communications system in claim 40, wherein the gateway node periodically renews the quality of service reservation.

45. The mobile communications system in claim 40, wherein the gateway node schedules transfer of packets corresponding to one of the two data packet streams to ensure that the reserved quality of service for that is met.

46. The mobile communications system in claim 40, wherein the gateway node classifies packets using the reserved quality of service for the application flow to which each packet belongs.

47. The mobile communications system in claim 40, wherein the serving node includes:

a first set of queues storing packets having the same quality of service class and data packet communications session;

a second set of queues storing packet having the same quality of service class and the same mobile terminal; and

a third set of queues storing packets being served in the same geographic area and having the same quality of service class.

48. In a mobile communications system including a packet network connected to an external network, a mobile terminal comprising:

a reservation controller reserving a different quality of service for different ones of plural data packet streams associated with corresponding applications operating at the mobile terminal and established during a data session when the mobile terminal is

attached to the packet network, where packets in the plural application flows are originated from the external network and are directed to the mobile terminal.

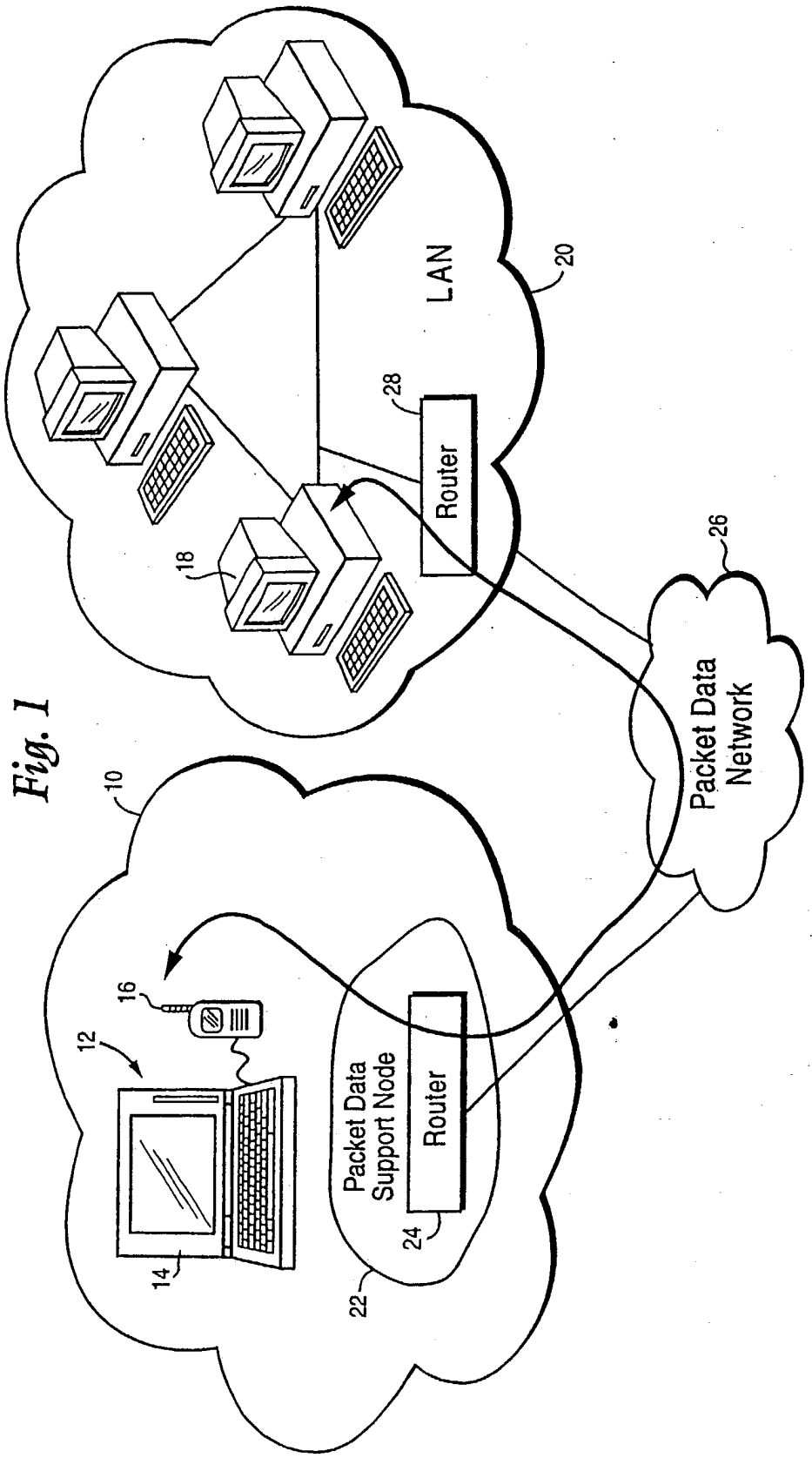
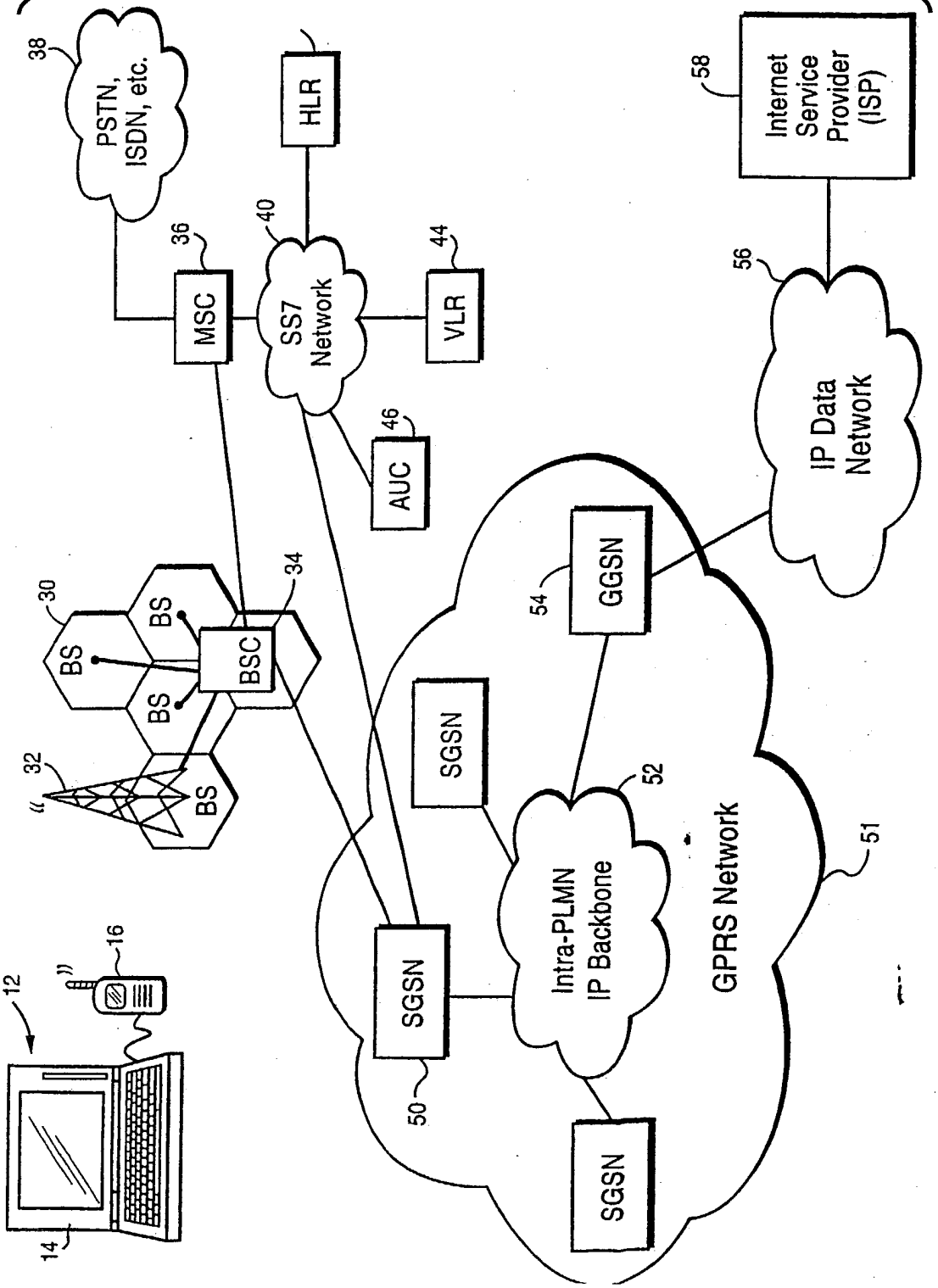

LAN
20
28
Router
18
26
Packet Data
Network
10
16
12
Packet Data
Support Node
Router
24
22
14

Fig. 1

Fig. 2


PSTN, ISDN, etc.
38
HLR
Internet Service Provider (ISP)
58
MSC
36
40
SS7 Network
44
VLR
56
IP Data Network
AUC
46
GGSN
54
BS
30
BSC
34
SGSN
32
Intra-PLMN IP Backbone
52
GPRS Network
51
SGSN
50
SGSN
16
12
14

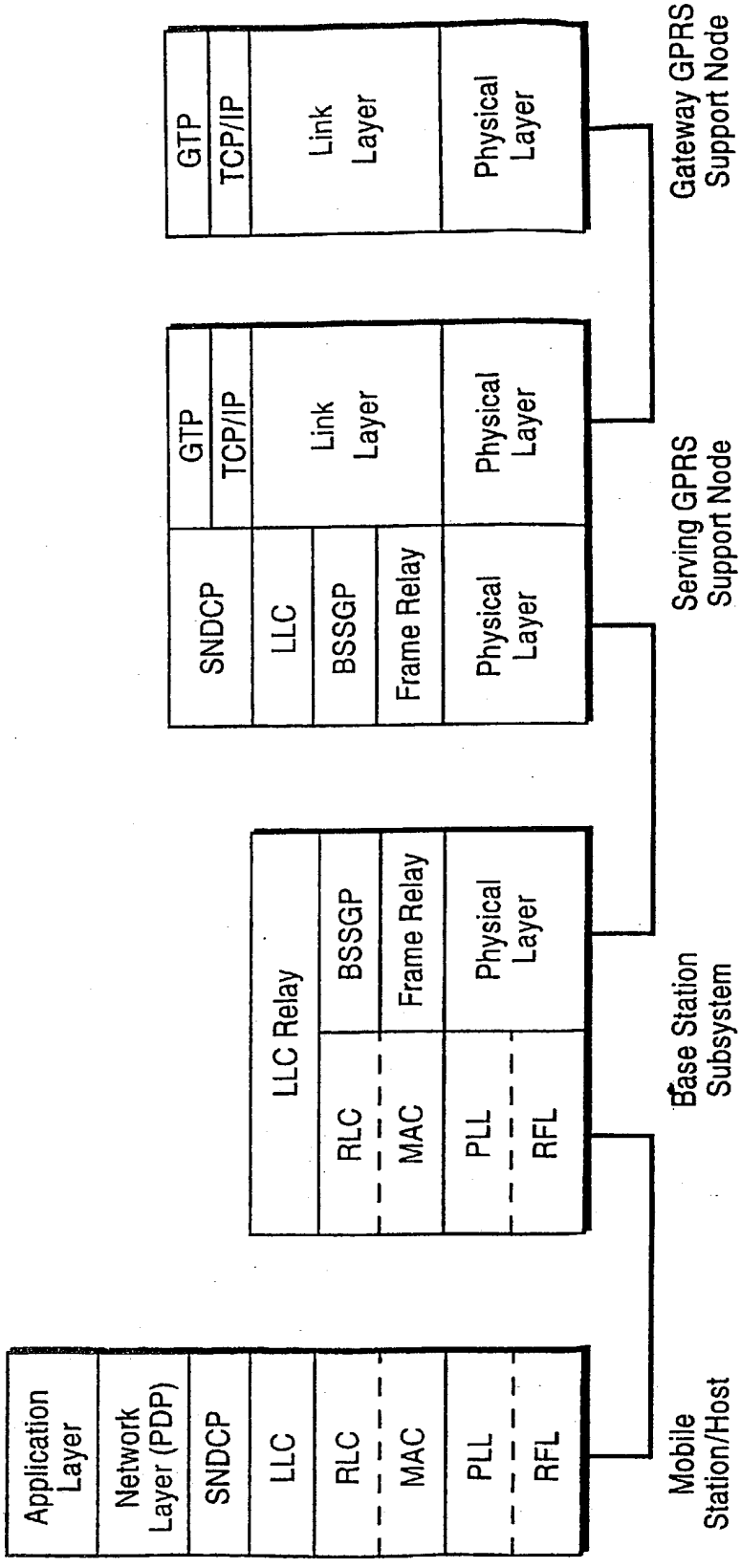

Application Layer
Network Layer (PDP)
SNDCP
LLC
RLC
MAC
PLL
RFL
Mobile Station/Host
LLC Relay
BSSGP
Frame Relay
Physical Layer
RLC
MAC
PLL
RFL
Base Station Subsystem
SNDCP
LLC
BSSGP
Frame Relay
Physical Layer
GTP
TCP/IP
Link Layer
Physical Layer
Serving GPRS Support Node
GTP
TCP/IP
Link Layer
Physical Layer
Gateway GPRS Support Node

Fig. 3

Fig. 4

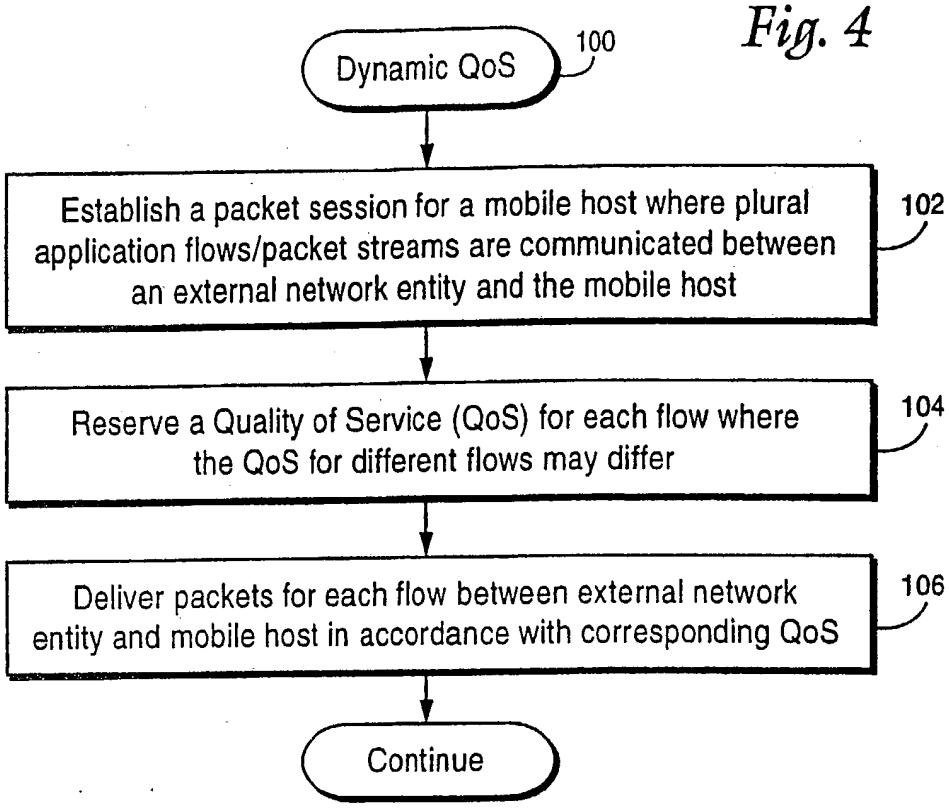
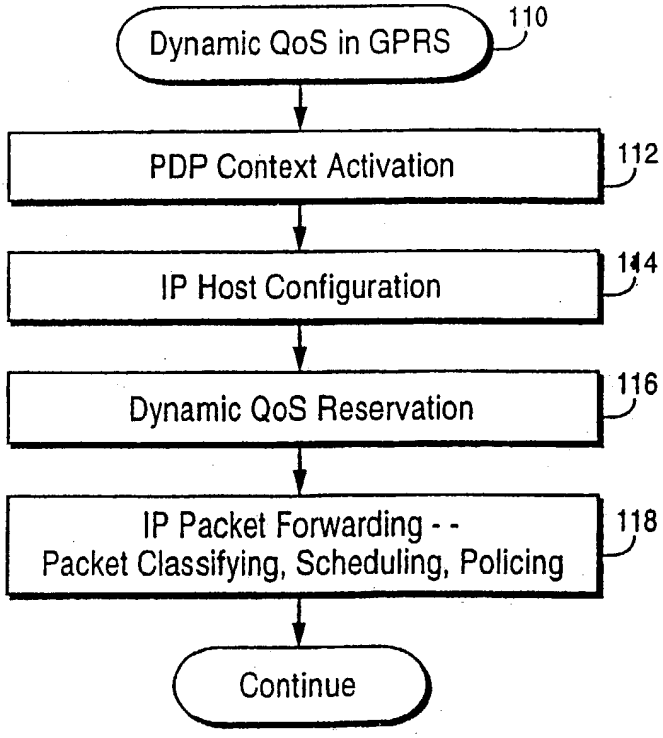

Dynamic QoS
100
Establish a packet session for a mobile host where plural application flows/packet streams are communicated between an external network entity and the mobile host
102
Reserve a Quality of Service (QoS) for each flow where the QoS for different flows may differ
104
Deliver packets for each flow between external network entity and mobile host in accordance with corresponding QoS
106
Continue

Fig. 5


Dynamic QoS in GPRS
110
PDP Context Activation
112
IP Host Configuration
114
Dynamic QoS Reservation
116
IP Packet Forwarding - -
Packet Classifying, Scheduling, Policing
118
Continue

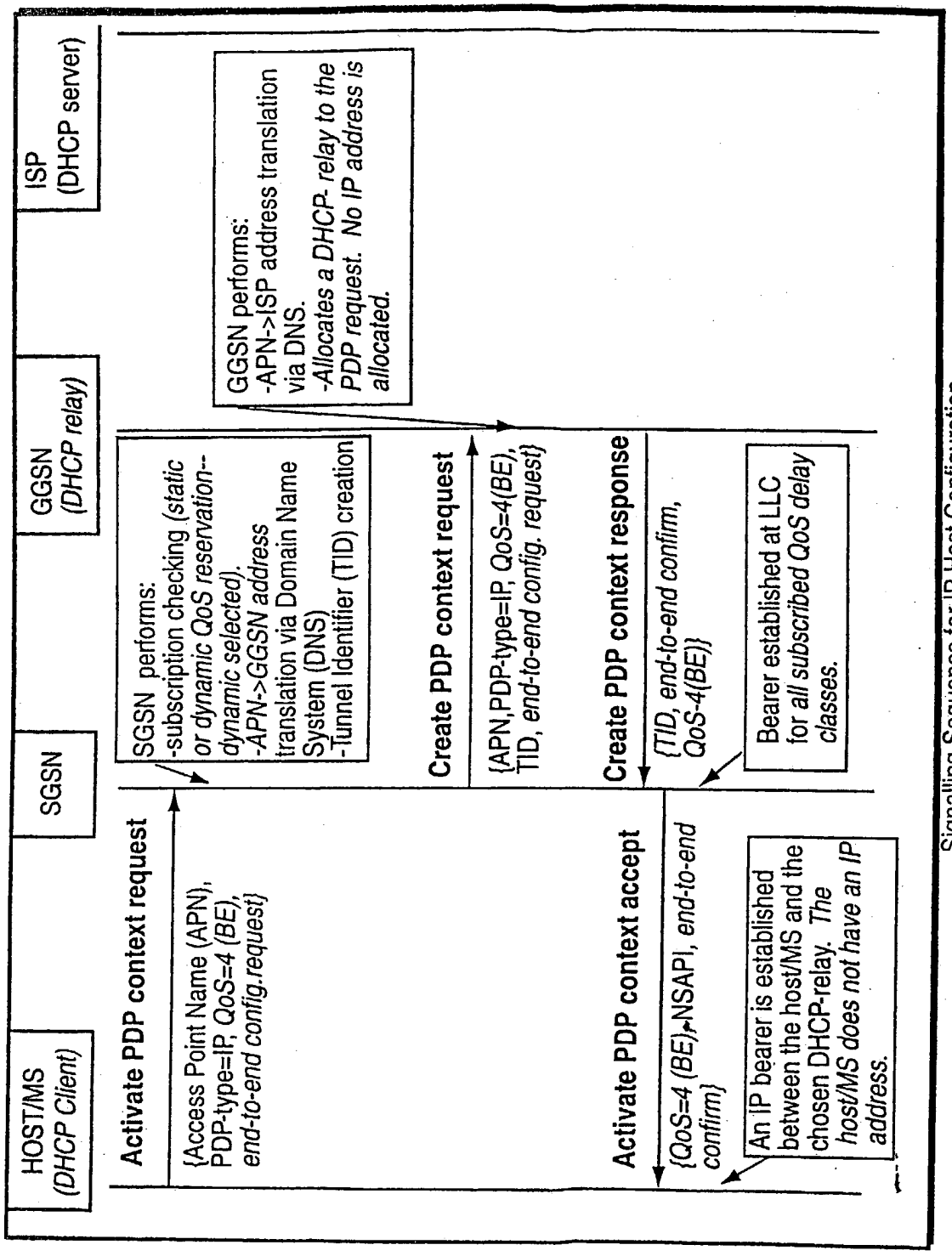


Fig. 6

Signalling Sequence for IP Host Configuration.

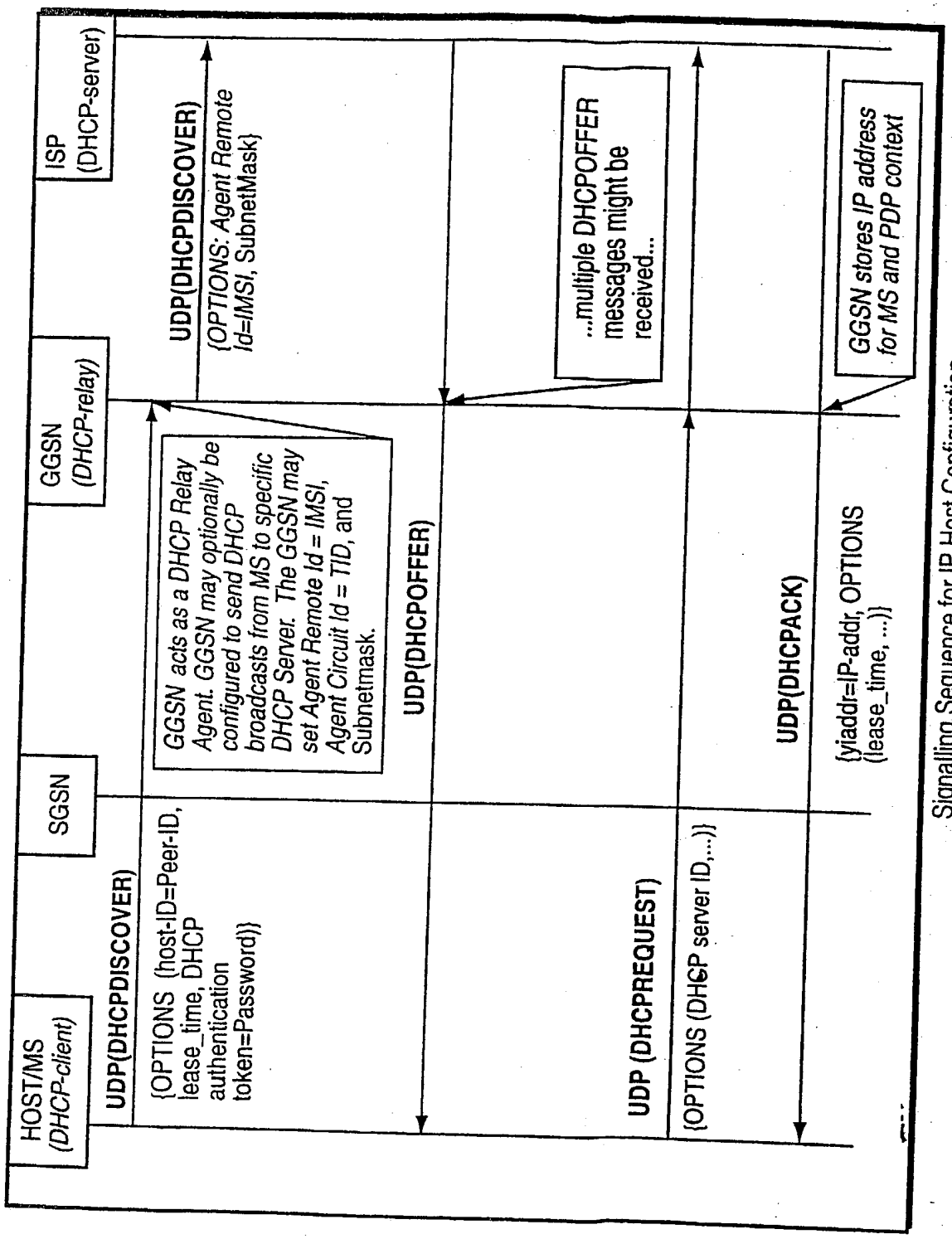


Fig. 7

Signalling Sequence for IP Host Configuration.

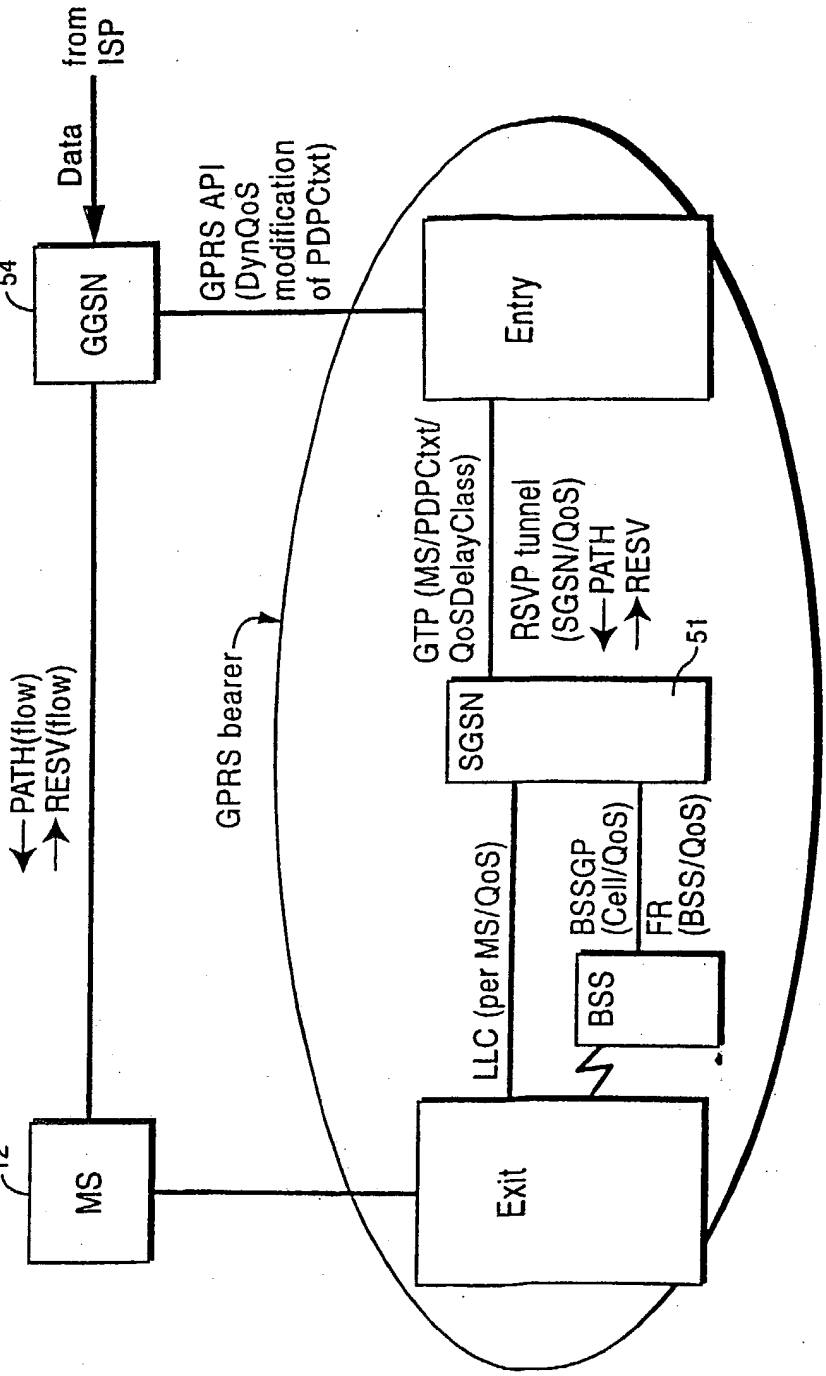
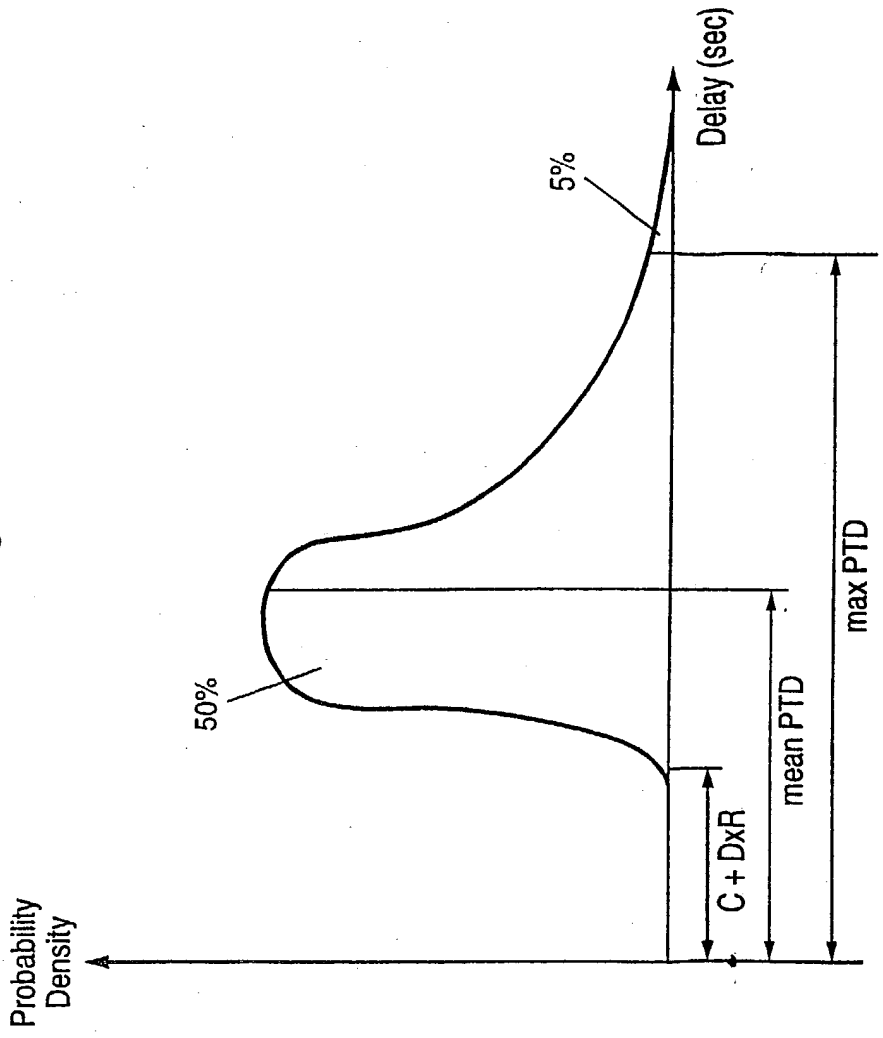


Fig. 8

QoS Reservation: Mobile Terminating Traffic Case.

Fig. 9



Delay Probability Definitions for the GPRS bearer.

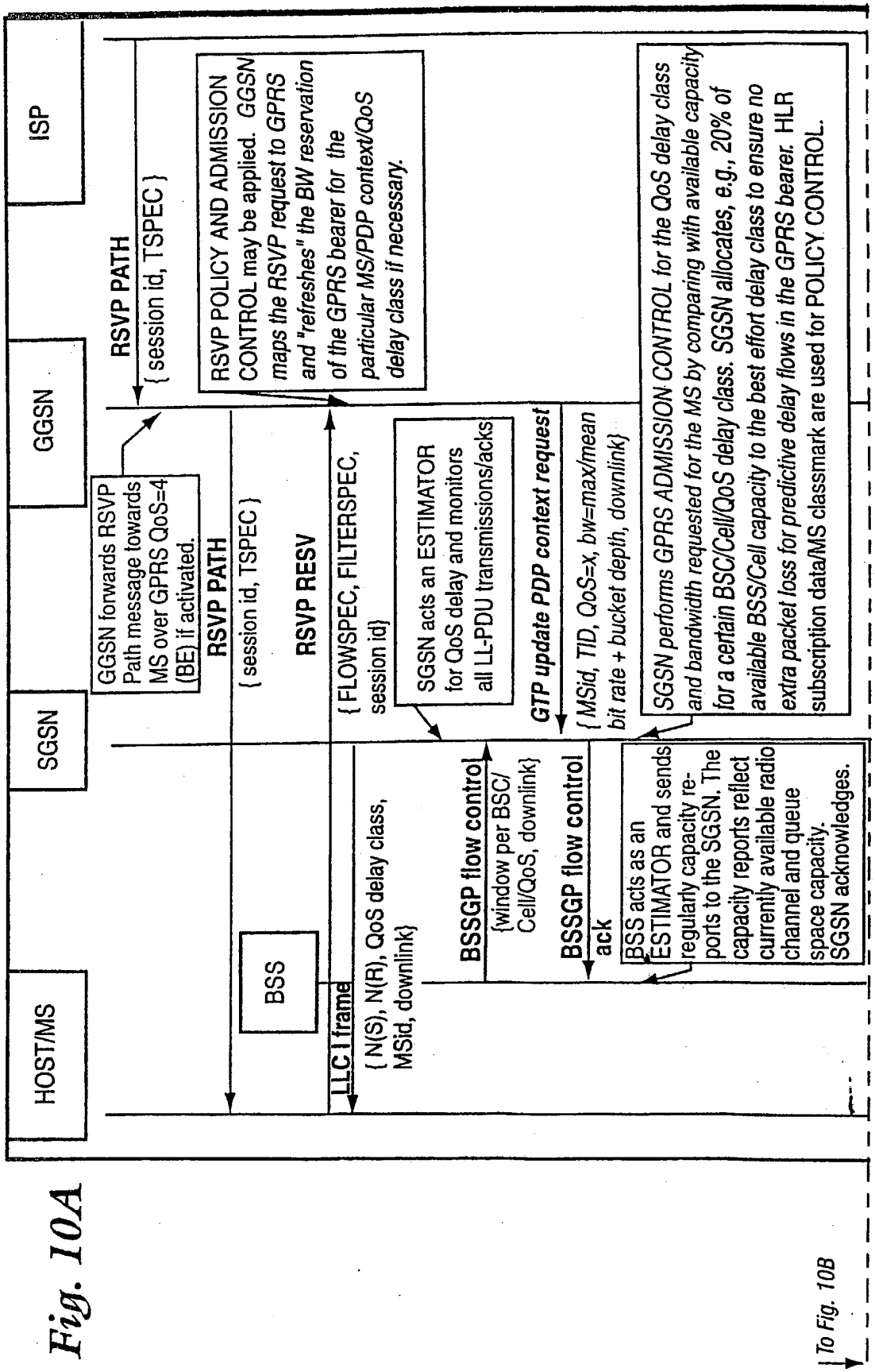

HOST/MS
BSS
SGSN
GGSN
ISP
RSVP PATH
{ session id, TSPEC }
RSVP POLICY AND ADMISSION CONTROL may be applied. GGSN maps the RSVP request to GPRS and "refreshes" the BW reservation of the GPRS bearer for the particular MS/PDP context/QoS delay class if necessary.
GGSN forwards RSVP Path message towards MS over GPRS QoS=4 (BE) if activated.
RSVP PATH
{ session id, TSPEC }
RSVP RESV
{ FLOWSPEC, FILTERSPEC, session id}
SGSN acts an ESTIMATOR for QoS delay and monitors all LL-PDU transmissions/acks
GTP update PDP context request
{ MSid, TID, QoS=x, bw=max/mean bit rate + bucket depth, downlink}
SGSN performs GPRS ADMISSION CONTROL for the QoS delay class and bandwidth requested for the MS by comparing with available capacity for a certain BSC/Cell/QoS delay class. SGSN allocates, e.g., 20% of available BSS/Cell capacity to the best effort delay class to ensure no extra packet loss for predictive delay flows in the GPRS bearer. HLR subscription data/MS classmark are used for POLICY CONTROL.
LLC I frame
{ N(S), N(R), QoS delay class, MSid, downlink}
BSSGP flow control
{window per BSC/ Cell/QoS, downlink}
BSSGP flow control ack
BSS acts as an ESTIMATOR and sends regularly capacity re-ports to the SGSN. The capacity reports reflect currently available radio channel and queue space capacity. SGSN acknowledges.
To Fig. 10B

Fig. 10A

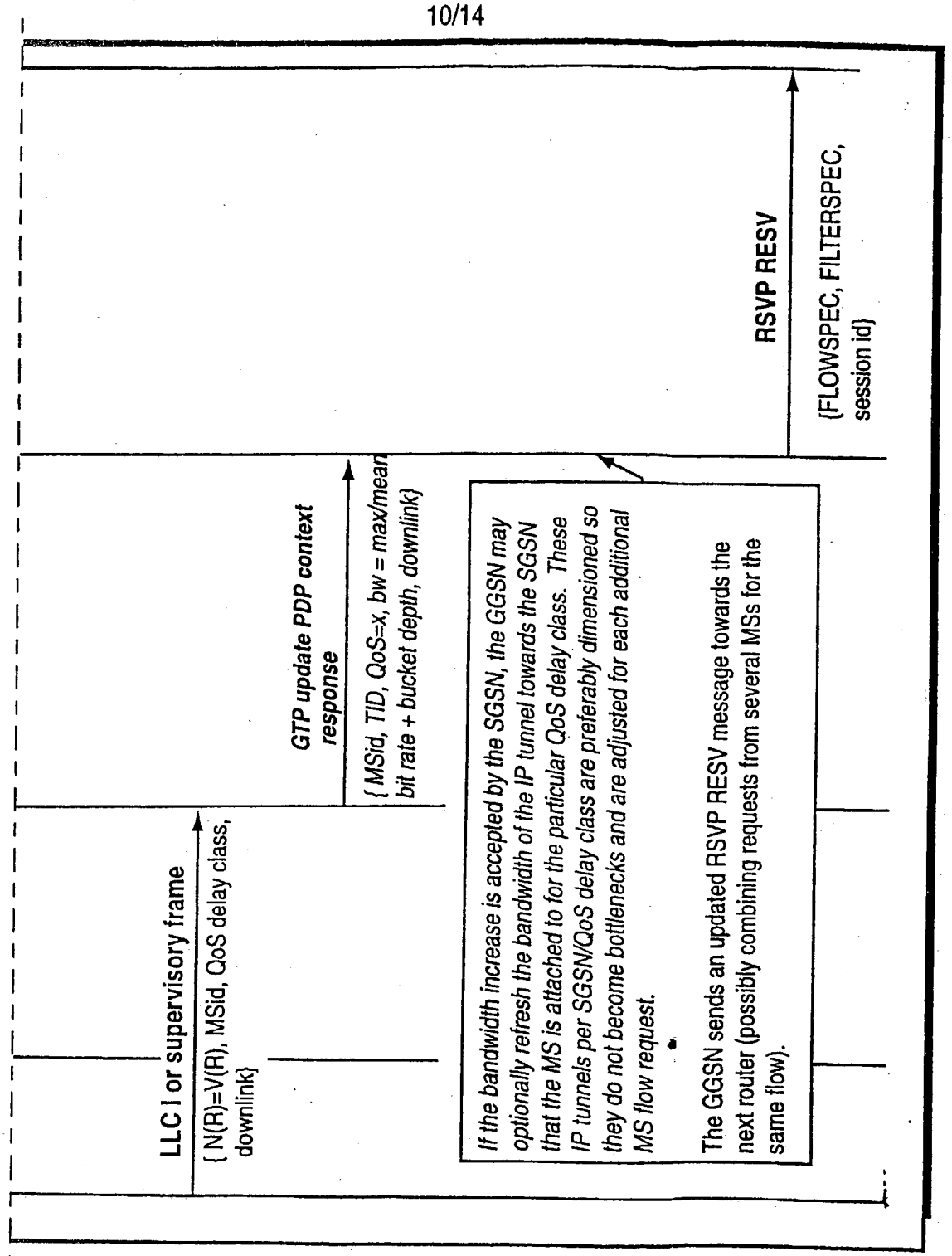

From Fig. 10A
LLC I or supervisory frame
{ N(R)=V(R), MSid, QoS delay class, downlink}
GTP update PDP context response
{ MSid, TID, QoS=x, bw = max/mean bit rate + bucket depth, downlink}
If the bandwidth increase is accepted by the SGSN, the GGSN may optionally refresh the bandwidth of the IP tunnel towards the SGSN that the MS is attached to for the particular QoS delay class. These IP tunnels per SGSN/QoS delay class are preferably dimensioned so they do not become bottlenecks and are adjusted for each additional MS flow request.
The GGSN sends an updated RSVP RESV message towards the next router (possibly combining requests from several MSs for the same flow).
RSVP RESV
{FLOWSPEC, FILTERSPEC, session id}

Fig. 10B

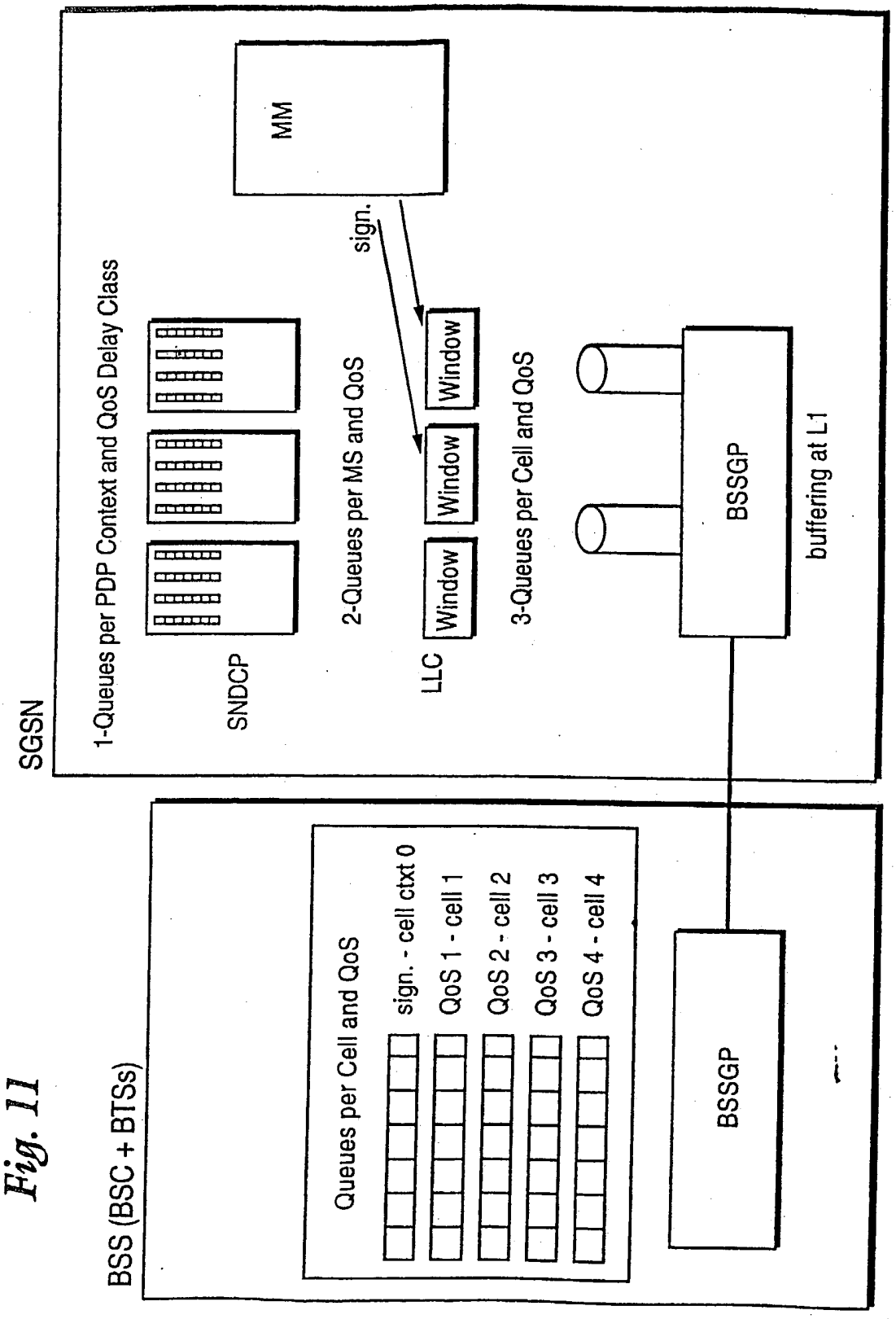

SGSN
1-Queues per PDP Context and QoS Delay Class
SNDCP
2-Queues per MS and QoS
LLC
Window
Window
Window
sign.
MM
3-Queues per Cell and QoS
BSSGP
buffering at L1
BSS (BSC + BTSs)
Queues per Cell and QoS
sign. - cell ctxt 0
QoS 1 - cell 1
QoS 2 - cell 2
QoS 3 - cell 3
QoS 4 - cell 4
BSSGP

Fig. 11

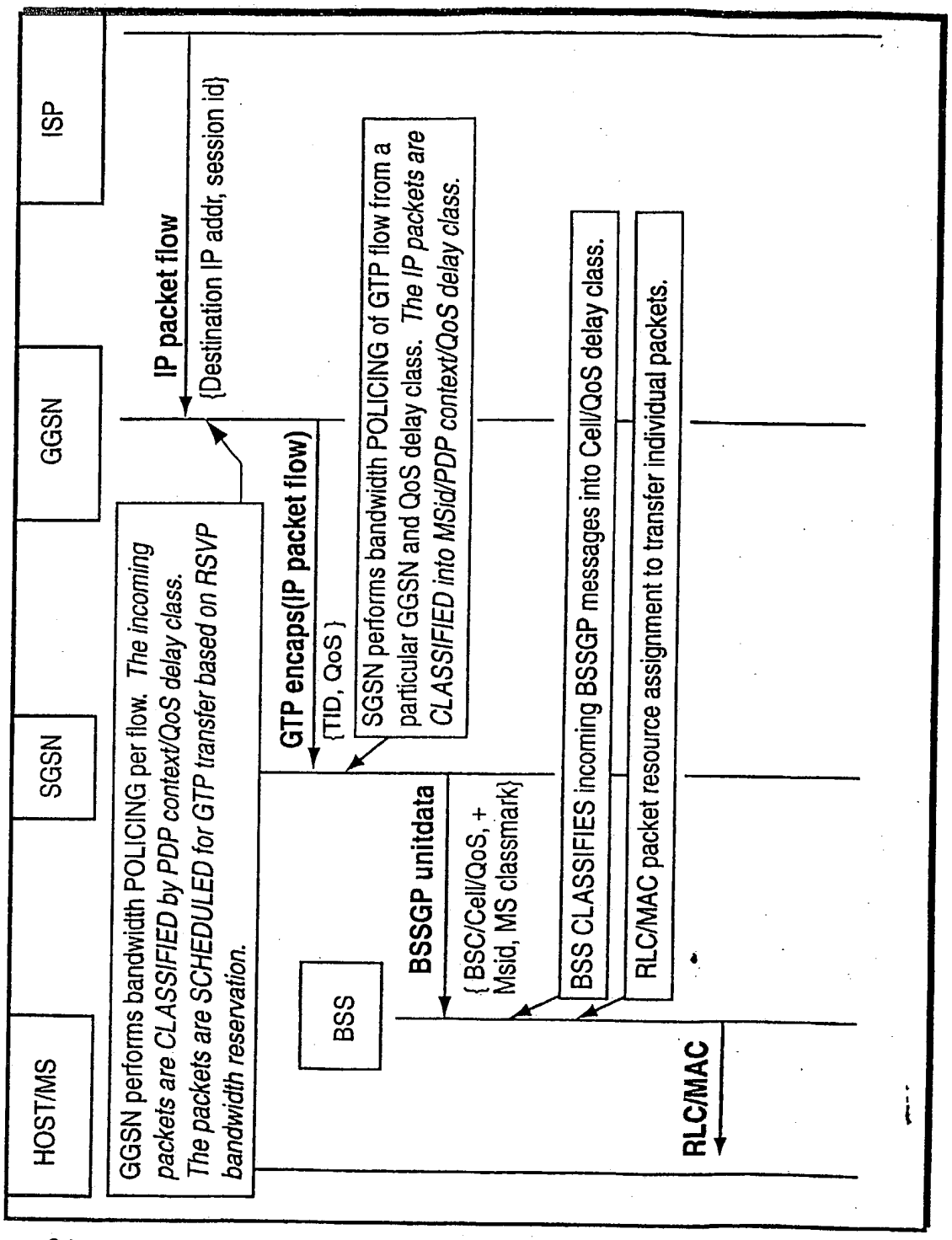

HOST/MS
SGSN
GGSN
ISP
GGSN performs bandwidth POLICING per flow. The incoming packets are CLASSIFIED by PDP context/QoS delay class. The packets are SCHEDULED for GTP transfer based on RSVP bandwidth reservation.
IP packet flow
{Destination IP addr, session id}
GTP encaps(IP packet flow)
{TID, QoS }
SGSN performs bandwidth POLICING of GTP flow from a particular GGSN and QoS delay class. The IP packets are CLASSIFIED into MSid/PDP context/QoS delay class.
BSS
BSSGP unitdata
{ BSC/Cell/QoS, + Msid, MS classmark}
BSS CLASSIFIES incoming BSSGP messages into Cell/QoS delay class.
RLC/MAC packet resource assignment to transfer individual packets.
RLC/MAC

Fig. 12

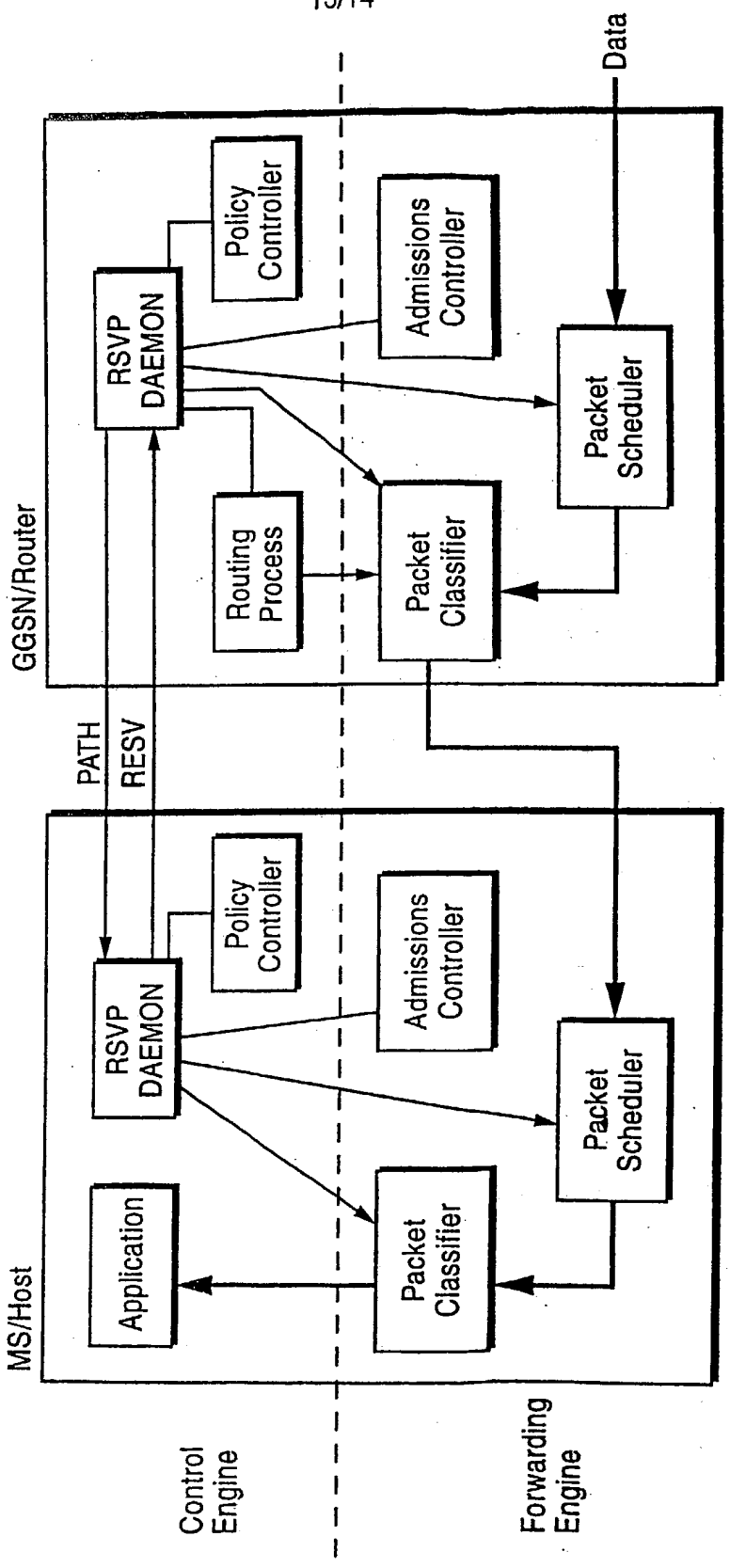

Data
GGSN/Router
Policy Controller
Admissions Controller
RSVP DAEMON
Packet Scheduler
Routing Process
Packet Classifier
PATH
RESV
MS/Host
Policy Controller
Admissions Controller
RSVP DAEMON
Packet Scheduler
Application
Packet Classifier
Control Engine
Forwarding Engine

Fig. 13

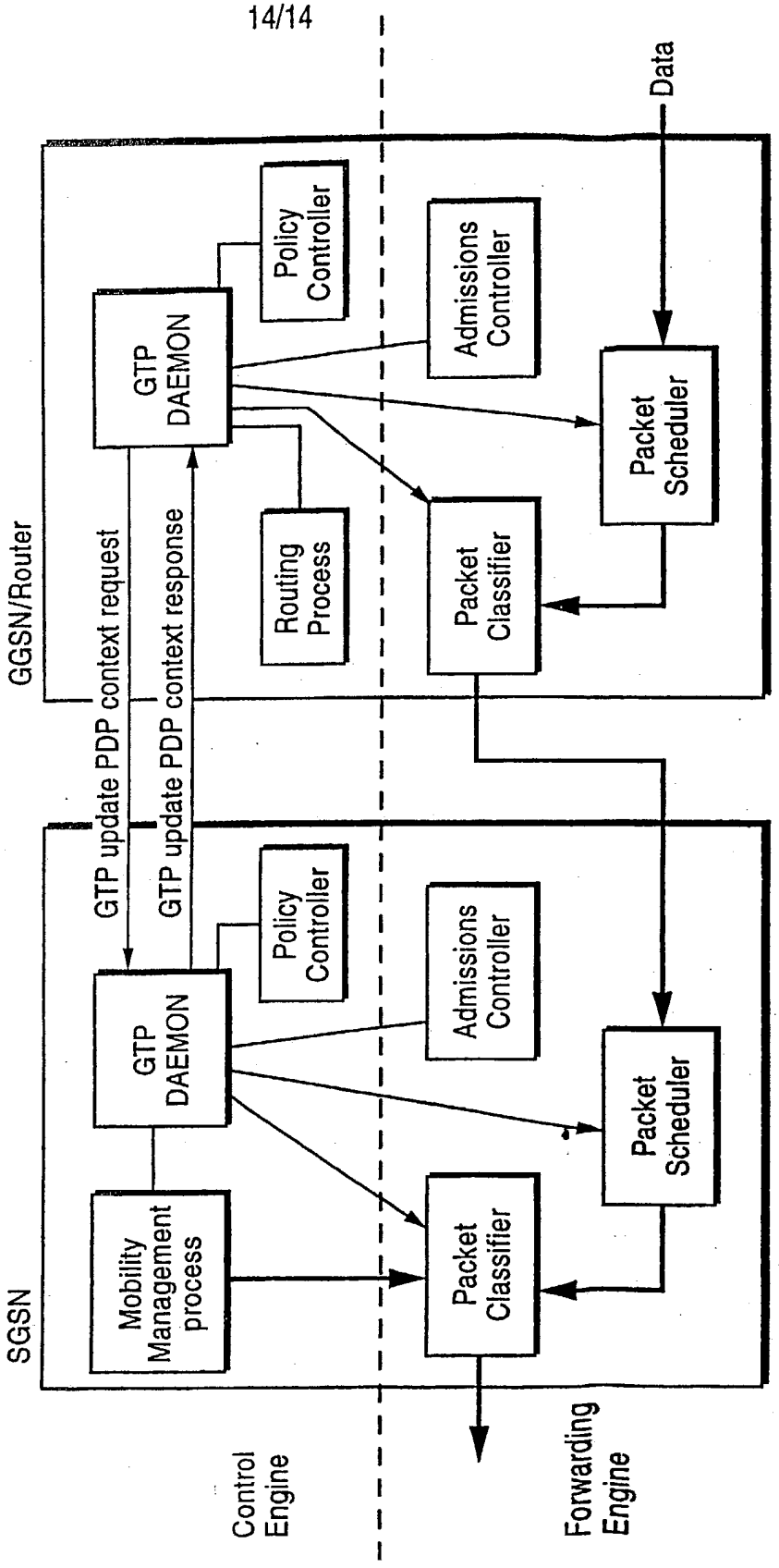

Data
GGSN/Router
GTP DAEMON
Policy Controller
Admissions Controller
Packet Scheduler
Routing Process
Packet Classifier
GTP update PDP context request
GTP update PDP context response
SGSN
GTP DAEMON
Policy Controller
Admissions Controller
Packet Scheduler
Mobility Management process
Packet Classifier
Control Engine
Forwarding Engine

Fig. 14

A. CLASSIFICATION OF SUBJECT MATTER
IPC 6 H04L12/56 H04Q7/22

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 6 H04L H04Q

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	EP 0 632 672 A (IBM) 4 January 1995 see column 1, line 3 - column 2, line 5 see column 3, line 1 - column 5, line 28 see column 6, line 24 - column 10, line 3 see column 11, line 39 - column 12, line 54 see column 13, line 16 - line 33	33,34, 36,38,48
Y		1,2,4,6, 35,37, 40,41
A		3,5,7,9, 10,18, 29,39, 42-47

-/--

[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

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Date of the actual completion of the international search	Date of mailing of the international search report
11 November 1998	27/11/1998

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C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	ANDREW S. TANENBAUM: "Computer Networks" 1993 , PRENTICE-HALL INTERNATION EDITIONS , ENGLEWOOD CLIFFS, US XP002083915 196050 see page 183, paragraph 3.7.2. see page 272, paragraph 5.1.1. see page 337, paragraph 5.4.3.	1,2,4,6, 40,41
A		3,5,7,9, 10,18, 29,33, 39,48

Y	US 5 524 006 A (HLUCHYJ MICHAEL G ET AL) 4 June 1996 see column 1, line 15 - column 2, line 26	35
A		1,18,29, 33,34, 36-40

Y	US 5 592 476 A (CALAMVOKIS COSTAS ET AL) 7 January 1997 see column 3, line 61 - column 5, line 58 see column 15, line 10 - line 60 see column 19, line 20 - column 21, line 27 see column 27, line 46 - column 29, line 59	37
A		1,18,29, 33-36, 38-40,48

A	WO 97 09836 A (MOTOROLA INC) 13 March 1997 see page 1, line 13 - page 2, line 2 see page 9, line 22 - page 10, line 27 see page 12, line 12 - line 29	1,18,29, 33,48

A	EP 0 774 848 A (XEROX CORP) 21 May 1997 see abstract see page 2, line 56 - page 3, line 49 see page 4, line 13 - line 54 see page 7, line 17 - line 25 see page 10, line 11 - line 41	1,18,29, 33,48

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PCT/SE 98/01385

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		CA 2187643 A	22-08-1996
		EP 0755594 A	29-01-1997
		WO 9625810 A	22-08-1996
US 5592476 A	07-01-1997	EP 0680173 A	02-11-1995
		JP 7321822 A	08-12-1995
WO 9709836 A	13-03-1997	US 5752193 A	12-05-1998
		EP 0847657 A	17-06-1998
EP 0774848 A	21-05-1997	JP 9233101 A	05-09-1997

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INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification 6 :
H04Q 7/38, H04L 12/56

A2

(11) International Publication Number: WO 99/17579

(43) International Publication Date: 8 April 1999 (08.04.99)

(21) International Application Number: PCT/FI98/00768

(22) International Filing Date: 29 September 1998 (29.09.98)

(30) Priority Data:
973846 30 September 1997 (30.09.97) FI

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(74) Agent: KOLSTER OY AB; Iso Roobertinkatu 23, P.O. Box 148, FIN–00121 Helsinki (FI).

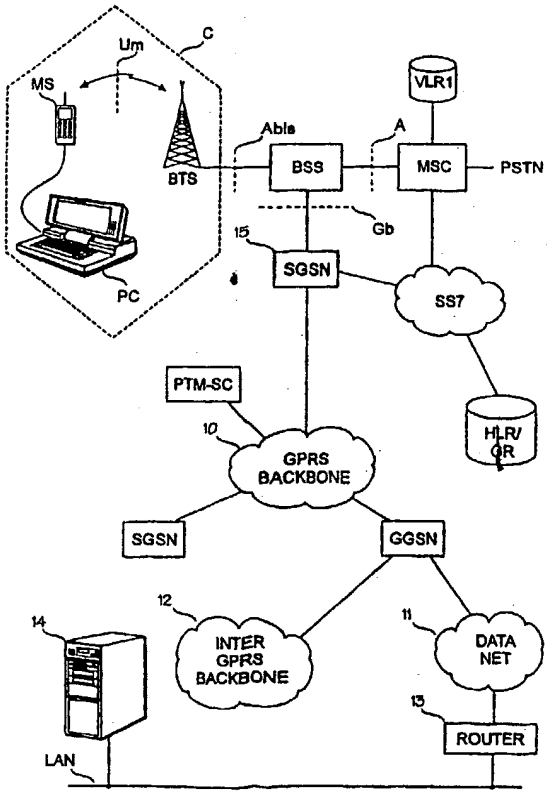
(81) Designated States: AL, AM, AT, AT (Utility model), AU, AZ, BA, BB, BG, BR, BY, CA, CH, CN, CU, CZ, CZ (Utility model), DE, DE (Utility model), DK, DK (Utility model), EE, EE (Utility model), ES, FI, FI (Utility model), GB, GD, GE, GH, GM, HR, HU, ID, IL, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MD, MG, MK, MN, MW, MX, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, SK (Utility model), SL, TJ, TM, TR, TT, UA, UG, US, UZ, VN, YU, ZW, ARIPO patent (GH, GM, KE, LS, MW, SD, SZ, UG, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GW, ML, MR, NE, SN, TD, TG).

Published
In English translation (filed in Finnish).
Without international search report and to be republished upon receipt of that report.

(54) Title: PAGING OF MOBILE SUBSCRIBER TO ESTABLISH PACKET–SWITCHED CONNECTION

(57) Abstract

A method of paging a mobile station (MS) to establish a packet–switched connection in a mobile telephone network that supports a circuit–switched connection and a packet–switched connection. To establish a mobile–terminated circuit–switched connection, the mobile telephone network sends the mobile station a page request, as a result of which the mobile station switches to standby mode for a circuit–switched connection. To save the batteries and to reduce the need of processing, the mobile station listens only to the paging channels of the circuit–switched connection. To establish a mobile–terminated packet–switched connection, the mobile telephone network sends the mobile station a page request via a circuit–switched connection and subsequently sends the mobile station the additional information commanding the mobile station to switch to a packet–switched connection. After detecting the additional information, the mobile station switches to the packet–switched connection.



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PAGING OF MOBILE SUBSCRIBER TO ESTABLISH PACKET-SWITCHED CONNECTION

BACKGROUND OF INVENTION

The invention relates to a mechanism for establishing a call, more particularly to a mechanism for paging a mobile station supporting a circuit-switched and a packet-switched connection in order to establish a packet-switched connection. The invention also relates to a mobile telephone network and to a mobile station.

Mobile systems have been developed because it has been necessary to be able to reach people even when they are not close to a fixed telephone terminal. The use of different data transmission services in offices has increased, and different data services have been simultaneously introduced into mobile systems. Portable computers allow efficient data processing wherever the user is. Mobile networks, in turn, offer the user an efficient access network for mobile data transmission, the access network providing access to actual data networks. Because of this, different new data services are being designed for present and future mobile networks. Mobile data transmission is particularly well supported by digital mobile systems, such as the Pan-European mobile system GSM (Global System for Mobile Communication).

A General Packet Radio Service (GPRS) is a new service in the GSM. It is one of the items that is being standardized in GSM phase 2+ in the ETSI (European Telecommunication Standard Institute). The GPRS operational environment consists of one or more sub-network service areas that are interconnected using a GPRS backbone network. A sub-network comprises a number of packet data service nodes, which are here called GPRS support nodes (or agents) and each one of which is connected to the GSM mobile network so that it can provide packet data service for mobile data terminals via several base stations, i.e. cells. An intermediate mobile network provides circuit-switched or packet-switched data transmission between a support node and the mobile data terminals. Different sub-networks, in turn, are connected to an external data network, for example to a Public Switched Packet Data Network PSPDN. The GPRS service can thus be used for effecting packet data transmission between mobile data terminals and external data networks, when the GSM network functions as an access network. One

feature of the GPRS service network is that it operates almost independently of the GSM network. One of the requirements set for the GPRS service is that it must operate together with different types of external PSPDN networks, such as the Internet and X.25 networks. In other words, the GPRS service and the GSM network should be able to serve all users, irrespective of the type of data networks that they wish to be connected to via the GSM network. This means that the GSM network and GPRS service must support and process different network addressing methods and data packet formats. The data packet processing also comprises routing of the packets in a packet radio network. In addition, the users should be able to roam from their home GPRS network to a visited GPRS network.

With reference to fig. 1, we shall now describe a typical arrangement in a GPRS network. It should be understood that the architecture of the GPRS systems is not as advanced as that of the GSM systems. All GPRS terms should therefore be understood as being descriptive terms rather than limiting ones. A typical mobile station forming a mobile data terminal consists of a mobile station MS of a mobile network and of a portable computer PC connected to the data interface of the MS. The mobile station can be, for example, a Nokia 2110, manufactured by Nokia Mobile Phones Ltd., Finland. By means of a PCMCIA type Nokia Cellular Datacard, manufactured by Nokia Mobile Phones Ltd., the mobile station can be connected to any portable personal computer PC whatsoever that has a PCMCIA card slot. The PCMCIA card thus provides the PC with an access point that supports the protocol of the telecommunications application used in the PC, such as the CCITT X.25 or Internet Protocol IP. Alternatively, the mobile station can directly provide an access point that supports the protocol used by the PC application. Further, a mobile station 3 and a PC 4 can also be integrated to form a single unit, within which the application is provided with an access point that supports the protocol used by it. An example for such a mobile station with an integrated computer is a Nokia Communicator 9000, manufactured by Nokia Mobile Phones Ltd., Finland.

Network elements BSC and MSC are previously known from a typical GSM network. The arrangement of fig. 1 comprises a separate Serving GPRS Support Node SGSN. The support node controls certain operations of the packet radio service on the network side. The operations include the logging on and off the system by the mobile stations MS, updating of the

routing areas of the mobile stations MS, and routing of the data packets to correct destinations. In the present application, the term 'data' should be understood in the wide sense to mean any information whatsoever transmitted in a digital telecommunications system. The information can comprise speech encoded into digital form, data communication between computers, telefax data, short segments of program code, etc. The SGSN node can be located at a base station BTS, at a base station controller BSC or at a mobile switching centre MSC, or it can be separate from all these elements. The interface between the SGSN node and the base station controller BSC is called a GB interface. An area managed by one base station controller BSC is called a Base Station Subsystem BSS.

The intermediate mobile network provides packet-switched data transmission between a support node and mobile data terminal equipment. Different sub-networks, in turn, are connected to an external data network, for example to a PSPDN, via specific Gateway GPRS Support Nodes GGSN. Packet data transmission between mobile data terminals and external data networks is thus effected by means of the GPRS service, while the GSM network functions as an access network. Alternatively, the gateway node GGSN can be replaced with a router. In the following, the term 'gateway node GGSN' is also to be understood as referring to a structure in which the gateway has been replaced with a router.

In fig. 1 the GPRS network connected to the GSM network comprises a number of serving GPRS support nodes and one gateway GPRS support node GGSN. The different support nodes SGSN and GGSN are interconnected via an intra-operator backbone network. It is to be understood that a GPRS network can comprise any number of support nodes SGSN and gateway nodes GGSN.

Each support node SGSN manages a packet data service in the area of one or more nodes in a cellular packet radio network. To achieve this, each support node SGSN is connected to a certain local of the GSM system, typically to a mobile services switching centre, but in some situations it may be preferable to connect it directly to a base station subsystem BSS, i.e. to a base station controller BSC or a base station BTS. A mobile station MS in a cell communicates with a base station BTS over a radio interface and further through a mobile network with the support node SGSN to the service area of which the cell belongs. In principle, the mobile network between the support

node SGSN and the mobile station MS only transmits packets between these two. For this purpose, the mobile network can offer either a circuit-switched connection or packet-switched data packet transmission between a mobile station MS and a serving support node SGSN. An example for a circuit-switched connection between a mobile station MS and an agent is presented in Finnish Patent Application 934 115. An example for packet-switched data transmission between a mobile station MS and an agent is presented in Finnish Patent Application 940 314. It should be noted, however, that a mobile network provides only a physical connection between a mobile station MS and a support node SGSN, and that its exact operation and structure are not relevant to the present invention.

An intra-operator backbone network 11 interconnecting the operator's SGSN and GGSN can be implemented, for example, using a local area network. It should be noted that it is also possible to implement the operator's GPRS network without an intra-operator backbone network, for example, by implementing all the features in a single computer, but this does not cause any changes in the call set-up principles according to the present invention.

A gateway GPRS node GGSN connects the operator's GPRS network to the other operators' GPRS systems and to data networks, such as an inter-operator backbone network 12 or an IP network. An Interworking Function IWF can be arranged between the gateway node GGSN and the other networks, but usually the GGSN is simultaneously the IWF. The inter-operator backbone network 12 is one through which the gateway nodes GGSN of different operators can communicate with one another. The communication is needed to support the GPRS roaming between the different GPRS networks.

The gateway node GGSN is also used to store the location information of the GPRS mobile stations. The GGSN also routes mobile-terminated (MT) data packets. The GGSN also contains a database that associates the mobile station's network address, for example in an IP network or an X.25 network (or simultaneously in more than one network), and the mobile station identifier in a GPRS network. When the mobile station roams from one cell to another within the area of one support node SGSN, location updating is needed only in the support node SGSN, and the gateway node GGSN need not be informed of the change of location. When the mobile

station roams from a cell of one support node SGSN to a cell of another SGSN within the area of the same or a different operator, location updating is also performed in the (home) gateway node GGSN so as to store the identifier of the new, visited support node and the identifier of the mobile station.

A GPRS register GR is used to authenticate subscribers at the beginning of a GPRS session. It contains a definition between a subscriber's PDP (Packet Data Protocol) address/addresses and the subscriber's IMSI (International Mobile Subscriber Identity). In a GSM network a subscriber is identified on the basis of the IMSI. The GR can be a separate register, or preferably it can be integrated with the home location register HLR of the mobile system. In the figure the HLR/GR is connected through an SS7 (Signalling System 7), for example to a mobile switching centre MSC and an intra-operator backbone network. Between the SS7 signalling system and the intra-operator backbone network there can be a direct connection or an SS7 gateway. In principle, the HLR/GR can exchange packet-switched messages with any GPRS node whatsoever. The HLR/GR's method of communication and its connection to the GPRS network are not, however, essential to the invention. For example, a direct connection to a node is possible, or the GR can be a node of the GPRS network.

In the above arrangement, packet-switched data (in short: packet data) can be transmitted to a mobile station over an air interface, when the mobile station, controlled by the network, has first been directed to a correct kind of channel, i.e. to a packet data transmission channel. A mobile station that supports packet data transmission can either be suited only to the transmission and reception of packet data ('GPRS only') or also to the transmission of conventional circuit-switched speech and other services ('multi-function terminal').

A 'GPRS only' mobile station can be in one of three different modes in the sense of the present application: a ready, a standby or an idle mode. A mobile station in the ready mode is connected to a data transmission channel and is ready to transmit and/or receive data packets. A mobile station in the standby mode listens to a packet data paging channel, and after receiving its paging identifier the mobile station switches to the ready mode. A mobile station in the idle mode does not support transmission nor reception of packet data.

A multi-function terminal operates in the ready and standby modes in the same was as the 'GPRS only' terminal, but in the idle mode it supports conventional circuit-switched services.

When packet data is sent to a mobile station, the data will be routed to the correct GSM network by routing it via the gateway node GGSN to the support node SGSN in which the location of the mobile station is known. If the mobile station is in the standby mode, its location is known with the accuracy of a Routing Area RA. Correspondingly, if the mobile station is in the ready mode, its location is known with the accuracy of a cell.

A problem in the above arrangement is that when a multi-function terminal is in the idle mode, i.e. when it listens to a paging channel associated with only circuit-switched services, such as a speech service, a mobile-terminated packet-switched connection cannot be established until the mobile station has connected to a channel that supports packet data. The mobile stations are usually designed to listen to only one paging channel at a time (e.g. to prolong the life of the batteries), and the channel is usually a speech service paging channel. The mobile station will not connect to a channel allocated for packet data transmission until necessary. Due to the nature of packet data, the establishment of a packet data connection is quite separate from the establishment of a circuit-switched connection.

BRIEF DESCRIPTION OF INVENTION

It is an object of the invention to provide a method and equipment implementing the method, eliminating the above problems. In particular, the object is to provide a mechanism combining two different mutually independent data transmission mechanisms, i.e. a circuit-switched connection and a packet-switched connection. The objects of the invention are achieved by a method and a system which are characterized by what is stated in the independent claims. The preferred embodiments of the invention are claimed in the dependent claims.

The invention is based on the idea that the mechanism used to establish a circuit-switched connection is supplemented with additional information commanding the mobile station to switch to a packet-switched connection. This simple, general solution poses another problem. The problem is how the mobile services switching centre in whose area the mobile station is roaming can be made to transmit a page provided with the additional

information according to the invention. The page notifies the mobile station that it is to switch to standby mode for a packet data connection. Different ways of solving the above problem will be described below in connection with Figs. 2 to 5.

It is an advantage of the method and arrangement of the invention that they are compatible with previously used paging mechanisms. Conventional mobile stations (e.g. GSM phones) do not regard additional information that they do not understand as interference. The invention does not shorten the life of the batteries, since the mobile station still listens to only one paging channel.

BRIEF DESCRIPTION OF FIGURES

In the following the invention will be described in greater detail by means of preferred embodiments and with reference to the attached drawings, in which

Fig. 1 illustrates the parts of the mobile system that are relevant to the present invention, and

Figs. 2 to 5 illustrate different embodiments of a call set-up mechanism according to the invention.

DETAILED DESCRIPTION OF INVENTION

With reference to Fig. 2, we shall now describe an embodiment of a call set-up mechanism according to the invention. In step 2-1 a gateway node GGSN detects that packet data is being supplied to a mobile station. The gateway node GGSN knows the identifiers of the mobile station for both a packet-switched and a circuit-switched connection (e.g. a GPRS identifier and an ISDN number). The GGSN establishes a call via a Public Switched Telephone Network PSTN to a GSM type home network of the mobile station, using the ISDN number of the mobile station. In the GSM network the incoming call event is processed in the same way as any other incoming call. In step 2-2 subscriber information is inquired of the home location register HLR, and in step 2-3 the HLR inquires the subscriber's location of the visitor location register VLR. In step 2-4 the subscriber's location is transmitted to a gateway MSC, i.e. GMSC. In step 2-5 the GMSC sends a call set-up request to a visited MSC, i.e. VMSC, which in step 2-6 forwards the call set-up request to a base station system BSS.

The messages sent in steps 2-1 to 2-6 include the additional information according to the invention forwarded by the GMSC to the VMSC. The VMSC interprets the additional information to mean that a packet-switched call is being supplied to the mobile station, and the VMSC therefore transmits via the base station system BSS to the mobile station MS a page that can be otherwise conventional but comprise additional information that commands the multi-function terminal to switch to standby mode for a packet-switched connection. When the VMSC has sent the page, it releases the connection backward toward the GGSN in accordance with the prior art.

With reference to Fig. 3, we shall now describe an alternative call set-up mechanism. Step 3-1 corresponds to step 2-1 described in connection with Fig. 2. In step 2-2 the GMSC processes the incoming call event and detects the additional information contained in the call set-up request. The GMSC requests the home location register HLR for the roaming number MSRN of the mobile station, and in step 3-3 the HLR inquires the same of the visitor location register VLR, but these messages include the additional information according to the invention. In step 3-4 the VMSC forwards the call set-up request to the base station system BSS. The additional information according to the invention included in this message contains a command for the multi-function terminal to switch to standby mode for a packet-switched connection in the same way as in step 2-6 of Fig. 2.

In an alternative embodiment, the call in steps 2-1 and 3-1 is not started in the GGSN but in the SGSN.

Fig. 4 illustrates an alternative call set-up mechanism. In step 4-1 the GGSN detects that packet data is being supplied to the mobile station. The GGSN knows the identifiers of the mobile station both for a packet-switched and for a circuit-switched connection (e.g. a GPRS identifier and an ISDN number). The GGSN sends the home location register HLR an MAP message transmitted in conventional call establishment from the GMSC. In other words, it requests for a roaming number from the HLR using the normal set-up procedure for an incoming call. In step 4-2 the HLR inquires the same of the VLR. These messages include the additional information according to the invention. When the visitor location register VLR receives the additional information from the HLR, it supplements the page request sent by the VMSC in step 4-3 with the additional information according to the invention, the information commanding the multi-function terminal to switch to standby mode.

In an alternative embodiment, the procedure begins in the GGSN rather than in the SGSN.

Fig. 5 illustrates another alternative call set-up mechanism. In step 5-1 the GGSN detects that packet data is being supplied to the mobile station. The GGSN knows the identifiers of the mobile station both for a packet-switched and for a circuit-switched connection (e.g. a GPRS identifier and an ISDN number). The GGSN sends the Short Message Service Centre SMSC a notification indicating that a short message that contains a command to switch to standby mode should be transmitted to the multi-function terminal. In step 5-2 the short message service centre sends a short message to a mobile services switching centre MSC in a manner known per se, and in step 5-3 the MSC sends the message to the base station system BSS and further to the mobile station MS. In response to the short message, the mobile station switches to standby mode.

The additional information commanding the mobile station to switch to a packet-switched connection can be transmitted even before the switch to a speech mode on a known paging channel provided with the additional information. Alternatively, the additional information can be transmitted during the speech connection on a paging channel known per se. Particularly suitable paging channels are FACCH and SACCH channels.

The invention provides a relatively simple mechanism for switching a multi-function mobile station (supporting both circuit-switched and packet-switched connections) to standby mode for a packet-switched connection. The invention does not shorten the life of the mobile station batteries as compared with a known single-function mobile station. Further, the invention does not require that the multi-function terminal should have a parallel processing capacity (be able to listen to two channels simultaneously). The invention can be implemented using known equipment, by changing or supplementing the software.

It will be obvious to those skilled in the art that with the introduction of technical advances, the basic idea can be implemented in many different ways. The invention and its embodiments are thus not limited to the above examples but can vary within the scope of the claims.

CLAIMS

1. A method of paging a mobile station to establish a packet-switched connection in a mobile telephone network that supports a circuit-switched connection and a packet-switched connection, in which method:

to establish a mobile-terminated circuit-switched connection, the mobile telephone network sends the mobile station a page request, and

in response to said page request, the mobile station switches to standby mode for a circuit-switched connection,

characterized in that

the mobile station listens only to the paging channels of the circuit-switched connection,

to establish a mobile-terminated packet-switched connection, the mobile telephone network sends the mobile station a page request via the circuit-switched connection and subsequently sends the mobile station additional information commanding it to switch to a packet-switched connection, and

in response to the additional information, the mobile station switches to the packet-switched connection.

2. A method as claimed in claim 1, **characterized** in that the page request is sent as follows:

a node (GGSN, SGSN) knowing the identifiers of the mobile station for both a packet-switched and a circuit-switched connection is formed,

in response to said node (GGSN, SGSN) detecting that packet data is being supplied to the mobile station, the node establishes a call via a public switched telephone network (PSTN) and a gateway MSC (GMSC) to the home network of said mobile station using the ISDN number of the mobile station,

in the home network of the mobile station, information on the mobile station is requested from a home location register (HLR), which in turn inquires the mobile station's location of a visitor location register (VLR),

the location is forwarded via the gateway MSC (GMSC) and the public switched telephone network (PSTN) to a visited MSC (VMSC), which sends a call set-up request to the base station system (BSS).

3. A method as claimed in claim 1, **characterized** in that the page request is sent as follows:

a node (GGSN, SGSN) knowing the identifiers of the mobile station for both a packet-switched and a circuit-switched connection is formed,

in response to said node (GGSN, SGSN) detecting that packet data is being supplied to the mobile station, the node establishes a call via a public switched telephone network (PSTN) and a gateway MSC (GMSC) to the home network of said mobile station using the ISDN number of the mobile station,

in response to said gateway MSC (GMSC) detecting the additional information contained in the call set-up request, the gateway MSC (GMSC) inquires the mobile station's roaming number of the home location register (HLR) and in response to the inquiry the home location register (HLR) inquires the same of the visitor location register (VLR),

in response to the roaming number inquiry addressed to the visitor location register (VLR), the MSC (VMSC) with which said visitor location register (VLR) is associated sends a call set-up request to the base station system (BSS).

4. A method as claimed in claim 1, **characterized** in that the page request is sent as follows:

a node (GGSN, SGSN) knowing the identifiers of the mobile station for both a packet-switched and a circuit-switched connection is formed,

in response to said node (GGSN, SGSN) detecting that packet data is being supplied to the mobile station, the node establishes a call via a public switched telephone network (PSTN) and a gateway MSC (GMSC) to the home network of said mobile station using the ISDN number of the mobile station,

in response to said gateway MSC (GMSC) detecting the additional information contained in the call set-up request, the gateway MSC sends a short message service centre (SMSC) a message indicating that a short message containing a command to switch to standby mode should be sent to the mobile station,

in response to the message sent by the gateway MSC (GMSC), the short message service centre sends a short message via the MSC and the base station system (BSS) to the mobile station (MS), and

in response to said short message, the mobile station (MS) switches to standby mode for a packet-switched connection.

5. A method as claimed in any one of claims 1 to 4, **characterized** in that said additional information is sent to the mobile station on a paging channel known per se.

6. A method as claimed in any one of claims 1 to 4, **characterized** in that said additional information is sent during an on-going call on a paging channel known per se, preferably on a FACCH or SACCH channel.

7. An arrangement for paging a mobile station (MS) to establish a packet-switched connection in a mobile telephone network that supports a circuit-switched connection and a packet-switched connection, in which method:

the mobile telephone network is arranged to send the mobile station a page request to establish a mobile-terminated circuit-switched connection, and

in response to said page request, the mobile station is arranged to switch to standby mode for a circuit-switched connection,

characterized in that to establish a mobile-terminated packet-switched connection,

the mobile station (MS) is arranged to listen to paging channels only on the circuit-switched connection,

the mobile telephone network is arranged to send the mobile station (MS) a page request via the circuit-switched connection and to send the additional information to the mobile station, and

the mobile station (MS) is arranged to switch to a packet-switched connection in response to said additional information.

8. A mobile telephone network that supports a circuit-switched connection and a packet-switched connection and is arranged to send the mobile station a page request to establish a mobile-terminated circuit-switched connection, **characterized** in that the mobile telephone network is arranged to

send the mobile station a page request via the circuit-switched connection to establish the mobile-terminated packet-switched connection, and

send the mobile station the additional information to switch the mobile station to the packet-switched connection.

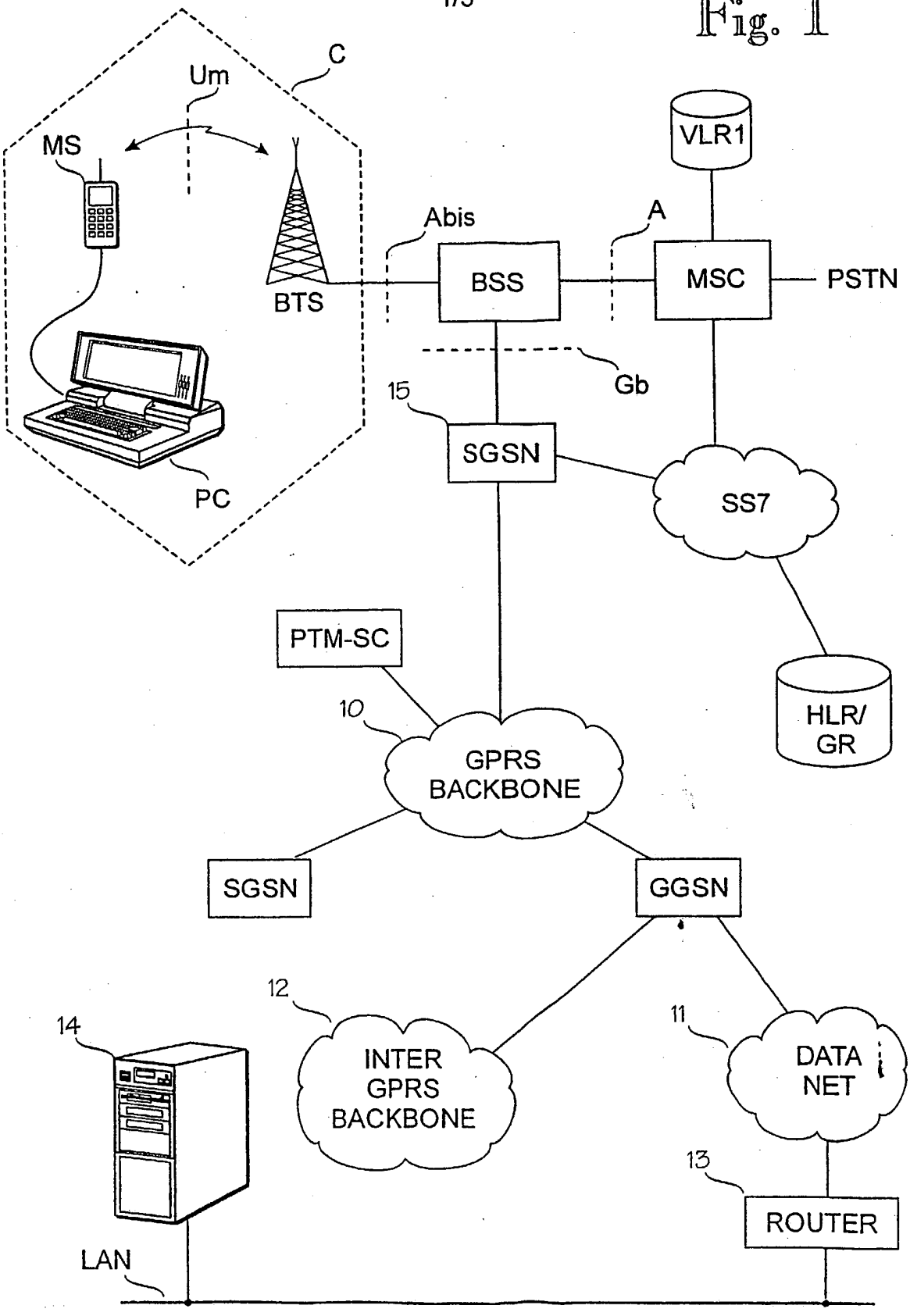
9. A mobile station (MS) that supports a circuit-switched connection and a packet-switched connection, a paging channel for paging a mobile station being associated at least with the circuit-switched connection, **characterized** in that the mobile station is arranged to

listen only to the paging channels of the circuit-switched connection,

monitor additional information sent on said circuit-switched connection, and

switch to the packet-switched connection in response to said additional information.

Fig. 1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BTS
PC
VLR1
Abis
A
BSS
MSC
PSTN
Gb
15
SGSN
SS7
PTM-SC
10
GPRS
BACKBONE
HLR/
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INTER
GPRS
BACKBONE
11
DATA
NET
14
13
ROUTER
LAN

Fig. 2

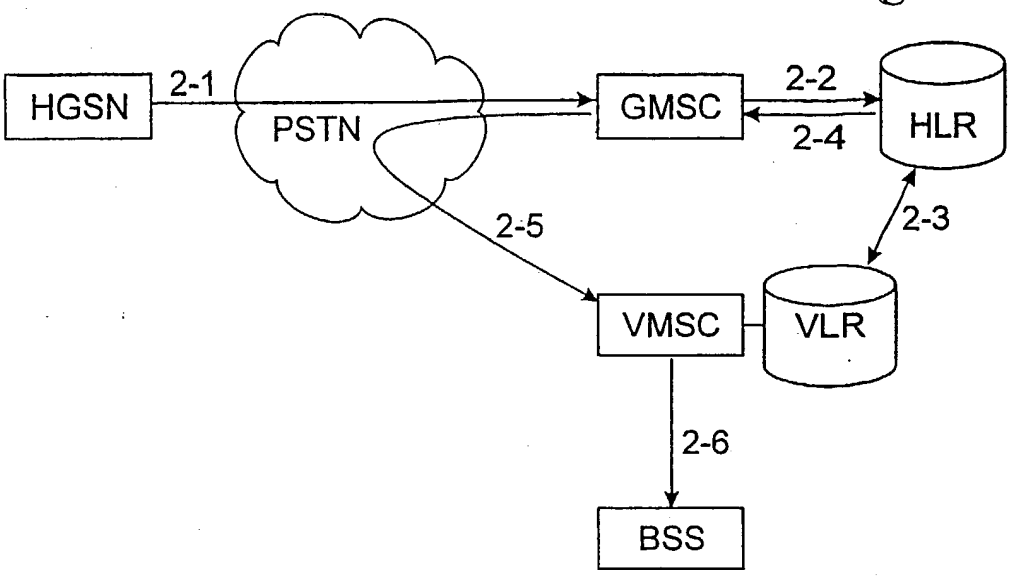

HGSN
2-1
PSTN
GMSC
2-2
2-4
HLR
2-3
2-5
VMSC
VLR
2-6
BSS

Fig. 3

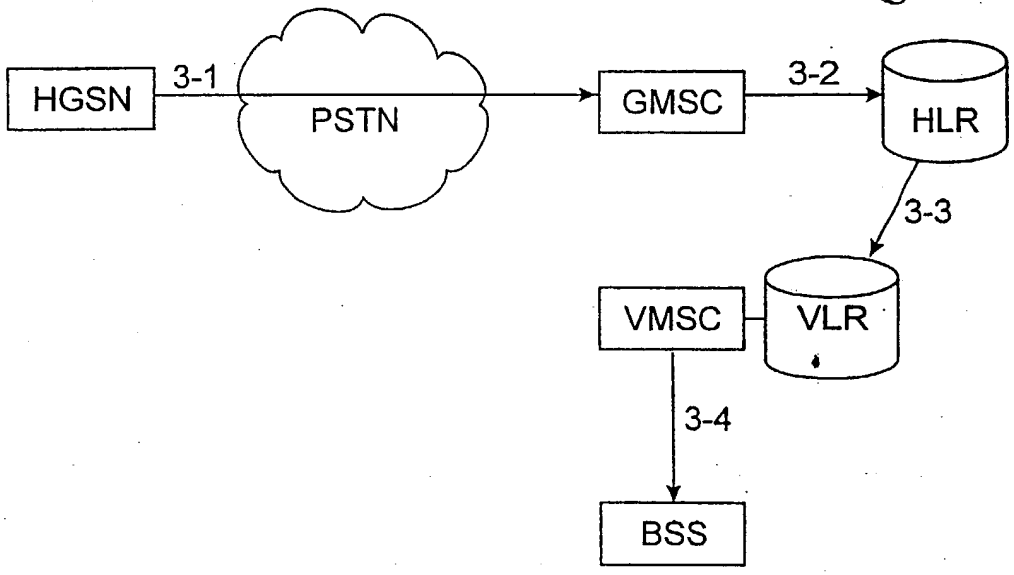

HGSN
3-1
PSTN
GMSC
3-2
HLR
3-3
VMSC
VLR
3-4
BSS

Fig. 4

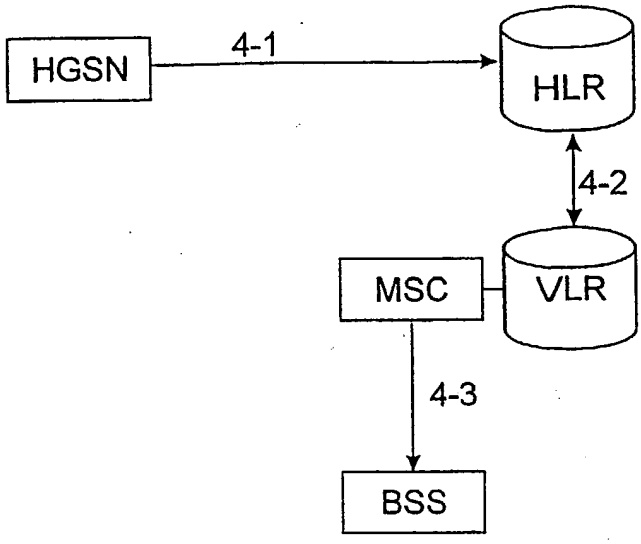
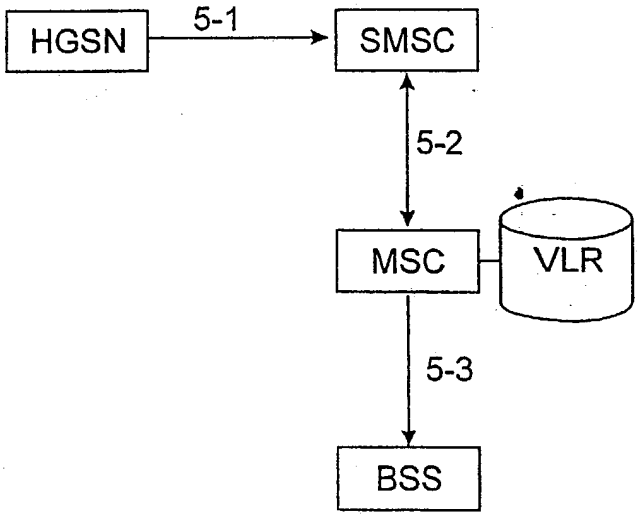


Fig. 5



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INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification 6 : H04M 7/00, H04Q 7/22 — A1

(11) International Publication Number: WO 99/43143

(43) International Publication Date: 26 August 1999 (26.08.99)

(21) International Application Number: PCT/SE99/00185

(22) International Filing Date: 12 February 1999 (12.02.99)

(30) Priority Data:
09/028,267 23 February 1998 (23.02.98) US

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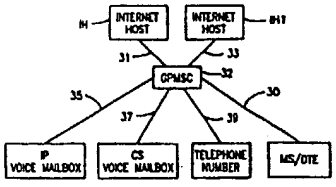
(81) Designated States: AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, CA, CH, CN, CU, CZ, DE, DK, EE, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MD, MG, MK, MN, MW, MX, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL, TJ, TM, TR, TT, UA, UG, UZ, VN, YU, ZW, ARIPO patent (GH, GM, KE, LS, MW, SD, SZ, UG, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GW, ML, MR, NE, SN, TD, TG).

Published
With international search report.
Before the expiration of the time limit for amending the claims and to be republished in the event of the receipt of amendments.

(54) Title: PROCESSING PACKET–SWITCHED VOICE CALLS DIRECTED TO A MOBILE UNIT OPERATING IN CIRCUIT–SWITCHED MODE

(57) Abstract

A packet–switched voice call directed to a mobile subscriber unit (MS/DTE) in a cellular communication network is processed by determining whether the mobile subscriber unit is in a circuit–switched mode of operation (23) and, if so, either forwarding the information in the packet–switched voice call to a destination other than the mobile subscriber unit or notifying the mobile subscriber unit (B, C, D, E) that the packet–switched voice call is waiting (51).



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GR	Greece
HU	Hungary
IE	Ireland
IL	Israel
IS	Iceland
IT	Italy
JP	Japan
KE	Kenya
KG	Kyrgyzstan
KP	Democratic People's Republic of Korea
KR	Republic of Korea
KZ	Kazakstan
LC	Saint Lucia
LI	Liechtenstein
LK	Sri Lanka
LR	Liberia
LS	Lesotho
LT	Lithuania
LU	Luxembourg
LV	Latvia
MC	Monaco
MD	Republic of Moldova
MG	Madagascar
MK	The former Yugoslav Republic of Macedonia
ML	Mali
MN	Mongolia
MR	Mauritania
MW	Malawi
MX	Mexico
NE	Niger
NL	Netherlands
NO	Norway
NZ	New Zealand
PL	Poland
PT	Portugal
RO	Romania
RU	Russian Federation
SD	Sudan
SE	Sweden
SG	Singapore
SI	Slovenia
SK	Slovakia
SN	Senegal
SZ	Swaziland
TD	Chad
TG	Togo
TJ	Tajikistan
TM	Turkmenistan
TR	Turkey
TT	Trinidad and Tobago
UA	Ukraine
UG	Uganda
US	United States of America
UZ	Uzbekistan
VN	Viet Nam
YU	Yugoslavia
ZW	Zimbabwe

PROCESSING PACKET-SWITCHED VOICE CALLS DIRECTED TO A MOBILE UNIT OPERATING IN CIRCUIT-SWITCHED MODE

FIELD OF THE INVENTION

This invention relates generally to routing of communications in a cellular communication network and, more particularly, to routing of packet-switched voice calls directed to a mobile subscriber unit in a cellular communication network.

BACKGROUND OF THE INVENTION

FIGURE 1 illustrates the architecture of a conventional cellular communication network, for example the Personal Digital Cellular system. The mobile station or mobile subscriber unit MS is capable of conducting both circuit-switched communication and packet-switched communication in the cellular network. Moreover, the cellular network supports voice communication via circuit-switched connections and via packet switching. The mobile subscriber unit typically has a permanent address, for example an Internet Protocol (IP) address which is known by the network. The data terminal equipment (DTE) attached to the mobile subscriber unit is configured with the IP address.

When the Gateway Packet Mobile Services Switching Center (GPMSC) receives an incoming IP voice packet from the Internet Host IH via the Internet, GPMSC checks with the home location register HLR and the Visited Mobile Services Switching Center VMSC to see if the mobile subscriber unit MS to which the IP voice packet is directed is already busy in a circuit-switched (CS) call. The HLR tells GPMSC whether or not the mobile subscriber unit is in the packet mode, and the VMSC tells the GPMSC whether the mobile subscriber unit is in CS mode or is idle. If it is determined that the mobile subscriber unit is already busy in a CS call, then the incoming IP voice packets directed to the mobile subscriber unit will be rejected. If, on the other hand, the mobile subscriber unit is not busy in a circuit-switched call, then the GPMSC sets up a packet channel to MS/DTE, and an IP voice session between the Internet Host IH and the mobile subscriber unit can be established.

Also shown in FIGURE 1 are a Visited Packet Mobile Services Switching Center VPMSC, a Gateway Mobile Services Switching Center GMSC, a Public Switched Telephone Network PSTN, an Integrated Services Digital Network ISDN, and a radio network, all well known components of a conventional cellular network architecture.

The above-described conventional operation of the GPMSC is illustrated in FIGURE 2. If an IP voice call is received at 21, it is determined at 23 whether or not the mobile station is busy in a circuit-switched call. If the mobile station is busy in a circuit-switched call, then the IP voice packets are rejected at 25. If the mobile station is not busy in a circuit-switched call at 23, then the GPMSC sets up a packet channel to MS/DTE, and an IP voice session between the Internet Host IH and the mobile subscriber unit can be established at 27.

It is desirable in view of the foregoing to process incoming packet-switched voice calls such that the voice packets are not rejected if the mobile subscriber unit to which they are directed is busy in a circuit-switched call.

According to the present invention, packet-switched voice calls directed to a mobile subscriber unit that is busy in a circuit-switched call are accommodated without rejecting the voice packets. Either the information in the packet-switched voice call is forwarded to a destination other than the mobile subscriber unit, or the mobile subscriber unit is notified that the packet-switched voice call is waiting.

BRIEF DESCRIPTION OF THE DRAWINGS

FIGURE 1 illustrates a conventional cellular communication network.

FIGURE 2 illustrates operations performed by the GPMSC of FIGURE 1.

FIGURE 3 is a block diagram which conceptually illustrates how a GPMSC according to the present invention processes packet-switched voice calls directed to a mobile subscriber unit that is busy in a circuit-switched call.

FIGURE 4 illustrates the operation of the GPMSC of FIGURE 3 when it receives a packet-switched voice call directed to a mobile subscriber unit.

FIGURE 5 illustrates one exemplary response of the GPMSC when the mobile subscriber unit is busy in FIGURE 4.

FIGURE 6 illustrates one exemplary response of the GPMSC when the mobile subscriber unit is busy in FIGURE 4 or does not accept the call in FIGURE 5.

FIGURE 7 illustrates another exemplary response of the GPMSC when the mobile subscriber unit is busy in FIGURE 4 or does not accept the call in FIGURE 5.

FIGURE 8 illustrates another exemplary response of the GPMSC when the mobile subscriber unit is busy in FIGURE 4 or does not accept the call in FIGURE 5.

FIGURE 9 illustrates another exemplary response of the GPMSC when the mobile subscriber unit is busy in FIGURE 4 or does not accept the call in FIGURE 5.

FIGURE 10 illustrates one exemplary response of the GPMSC when the mobile subscriber unit accepts the call in FIGURE 5 in circuit-switched mode.

DETAILED DESCRIPTION

Example FIGURE 3 is a block diagram which illustrates the routing of packet-switched voice calls by a GPMSC 32 according to the present invention. The communication links at 30, 31, 33, 35, 37 and 39 are illustrated conceptually for clarity of exposition. A packet-switched voice call is received at an input of GPMSC 32 via one of the communication links. The GPMSC 32 responds to receipt of the call by providing at an output thereof a suitable communication to be carried, for example, by one of the communication links to one of the components shown in FIGURE 3. Workers in the art will readily comprehend from the following description the actual routing of communications in FIGURE 3.

Referencing also exemplary FIGURE 4, if at 21 the GPMSC 32 receives at an input thereof a packet-switched voice call (in this example an IP voice call from Internet Host IH), it is first determined at 23 whether or not the mobile subscriber unit is busy in a circuit-switched call. If not, then at 27 the GPMSC 32 sets up a packet channel to MS/DTE, and an IP voice session between the Internet Host IH and the mobile subscriber unit can be established. This voice session is conducted via the GPMSC 32 and the communication links 31 and 30. It will be noted that the operations at 21, 23 and 27 in FIGURE 4 are the same as the correspondingly numbered operations in prior art FIGURE 2. Thus, when the mobile subscriber unit is not busy in a circuit-switched call, the GPMSC 32 responds to an incoming packet-

switched voice call in the same manner as the prior art GPMSC described above with respect to exemplary FIGURES 1 and 2.

If at 23 the mobile subscriber unit is busy in a circuit-switched call, then the GPMSC 32 can respond by executing any one of five exemplary procedures designated at B, C, D, E and F in FIGURE 4.

The exemplary procedure designated at F in FIGURE 4 is the call waiting procedure of FIGURE 5. At 51 in the call waiting procedure, the GPMSC 32 notifies the mobile subscriber unit of the IP voice call. Use of a call-waiting notification is well known in the art. It is advantageous, however, to provide at the mobile subscriber unit a unique indication (e.g. audible) that enables the user to determine that the waiting call is a packet-switched voice call. The user of the mobile subscriber unit determines whether or not to accept the IP voice call. The decision of the user is transmitted to the GPMSC, and the GPMSC determines at 53 whether or not the user of the mobile subscriber unit has accepted the IP voice call. If not, then the GPMSC executes any one of the aforementioned procedures designated at B, C, D and E. If the user of the mobile subscriber unit accepts the IP call at 53, it is then determined at 55 whether the mobile subscriber unit has chosen to receive the IP voice call in circuit-switched mode or in packet-switched mode.

If circuit-switched mode is selected at 55, then the GPMSC executes the exemplary procedure designated at G in FIGURE 5. If packet-switched mode is selected, then the GPMSC sets up a packet channel to MS/DTE, and an IP voice session between the Internet Host IH and the mobile subscriber unit can be established (27). It will be noted that the IP voice session conducted at 27 in FIGURE 5 can be the same as the conventional IP voice session illustrated in FIGURES 2 and 4. After the IP voice session is completed at 27, the call waiting procedure of FIGURE 5 proceeds to point A of FIGURE 4 and thus re-enters the decision block 21 of FIGURE 4.

Exemplary FIGURE 6 illustrates the procedure designated at B in FIGURES 4 and 5. This procedure can be executed by GPMSC 32 when the mobile subscriber unit is busy in a circuit-switched call at 23 in FIGURE 4 or when the mobile subscriber unit does not accept the IP voice call at 53 in FIGURE 5. The procedure designated at B in FIGURES 4-6 is operative to set up and conduct an IP voice session

between the Internet Host IH and an IP voice mailbox (see FIGURE 3). In FIGURE 6, the GPMSC alters the source and destination addresses in the IP voice packets that are exchanged between the Internet Host IH and the IP voice mailbox.

If it is determined at 61 that a packet arriving at the GPMSC 32 is from the Internet Host IH, then at 63 the GPMSC changes the destination address in that packet to the address of the IP voice mailbox, and also changes the source address of that packet to the address of DTE. It will be noted that the destination address which is received from the Internet Host IH, and which is changed at 63 to the IP voice mailbox address, is the DTE address. It will likewise be noted that the source address which is received from the Internet Host IH, and which is replaced at 63 by the DTE address, is the address of the Internet Host IH. The destination address is changed to the IP voice mailbox address so that the packet is routed to the IP voice mailbox, and the source address is changed to the DTE address because the IP voice mailbox needs this address for identification of the mobile user. After the source address and destination address are changed at 63, the packet is released at 65.

It is thereafter determined at 67 whether there are any more packets in the IP voice session. If so, then control returns to decision block 61. If not, then control proceeds to point A of FIGURE 4 and thus re-enters decision block 21 of FIGURE 4. If the GPMSC receives a packet from the IP voice mailbox at 61, then at 69 the GPMSC 32 changes the destination address of that packet to the address of the Internet Host IH, and also changes the source address of that packet to the DTE address. It will be noted that a packet received at GPMSC 32 from the IP voice mailbox would have the DTE address for a destination address, and would have the IP voice mailbox address as a source address. These addresses supplied by the IP voice mailbox are changed at 69 in order to facilitate the IP voice session between the IP voice mailbox and the Internet Host IH. After the addresses are changed at 69, the packet is released at 65 as described above.

It will be recognized from the foregoing description of FIGURE 6 that GPMSC acts as a proxy server, translating the IP source and destination addresses. The packets received from the Internet Host IH have their destination addresses changed to permit them to be rerouted to the IP voice mailbox (instead of DTE), and also have their source addresses changed in order to permit the IP voice mailbox to identify them as

packets associated with DTE. According to the invention, the IP voice mailbox may include, for example, a look-up table including the MS/DTE addresses of all mobile stations that use the IP voice mailbox. When the IP voice mailbox receives a voice packet, it can first compare the source address of the packet to the MS/DTE address entries in the table. If a matching MS/DTE address is found in the table, then the IP voice mailbox stores the packet in the mailbox associated with the matched MS/DTE address. If no match is found, the IP voice mailbox discards the packet. It should also be noted that the IP voice mailbox should preferably be physically closely connected to GPMSC 32, for example, closely enough that packets exchanged therebetween would not need to traverse the Internet.

It will also be appreciated that packets received at GPMSC from the IP voice mailbox have their destination addresses changed to permit them to be rerouted to the Internet Host IH (instead of DTE), and have their source addresses changed in order to permit the Internet Host IH to accept them as packets from DTE. The GPMSC 32 makes it appear to the IP voice mailbox that packets from the Internet Host IH are instead from DTE, and also makes it appear to the Internet Host IH that packets from the IP voice mailbox are instead from DTE. This address mapping operation facilitates the IP voice session between the Internet Host IH and the IP voice mailbox.

FIGURE 7 illustrates another exemplary response of the GPMSC 32 when the mobile subscriber unit is busy at 23 in FIGURE 4 or when the mobile subscriber unit does not accept the IP voice call at 53 in FIGURE 5. The procedure in FIGURE 7 is designated at C in FIGURES 4, 5 and 7. In FIGURE 7, the GPMSC 32 sets up and conducts an IP voice session between the Internet Host IH and the Internet Host IH1 (see FIGURE 3). If a packet is received from the Internet Host IH at 71, then the destination address and source address of that packet are changed at 73. In particular, the destination address of the packet is changed to the address of Internet Host IH1, and the source address of the packet is changed to the address of GPMSC 32. It will be noted that the destination address as originally received from the Internet Host IH would have been the DTE address, and the source address would have been the address of the Internet Host IH. After the addresses are changed at 73, the packet is released at 75. Thereafter at 77, the GPMSC determines whether or not there are any more packets to be routed in the IP voice session. If so, then the procedure re-enters

decision block 71. If not, then the procedure moves to point A in FIGURE 4 to re-enter decision block 21 of FIGURE 4.

Packets received from Internet Host IH1 at 71 have their destination and source addresses changed at 79. More specifically, the destination address of such packets is changed to the address of the Internet Host IH, and the source address of such packets is changed to the address of DTE. It will be noted that the destination address of packets as received from Internet Host IH1 would be the address of GPMSC 32 and the source address of such packets would be the address of Internet Host IH1. After the addresses are changed at 79, the packet is released at 75 as described above.

It will be appreciated that the GPMSC acts as a proxy server in FIGURE 7, translating the IP addresses. By changing the addresses at 73 in FIGURE 7, the GPMSC 32 permits packets sent from Internet Host IH to DTE to be redirected by GPMSC to Internet Host IH1. The changing of addresses at 79 permits packets sent from the Internet Host IH1 to the GPMSC 32 to be forwarded from the GPMSC 32 to the Internet Host IH and to appear as though they originated at DTE. Thus, the address mapping procedures at 73 and 79 enable the GPMSC to conduct an IP voice session between the Internet Host IH and the Internet Host IH1.

FIGURE 8 illustrates another example response of the GPMSC when the mobile subscriber unit is busy at 23 in FIGURE 4 or the mobile subscriber unit does not accept the IP voice call at 53 in FIGURE 5. The procedure illustrated in FIGURE 8 is designated at D in FIGURES 4, 5 and 8. In FIGURE 8, the GPMSC sets up and conducts a conventional IP voice session between the Internet Host IH and the GPMSC, and also sets up and conducts a conventional CS voice session between the GPMSC and a conventional circuit-switched (CS) voice mailbox (see FIGURE 3).

At 81 in FIGURE 8, the GPMSC 32 translates or converts the IP voice packets received from the Internet Host IH into circuit-switched voice signals. The GPMSC sends the CS voice signals to the CS voice mailbox. At 83, the GPMSC 32 translates or converts CS voice signals received from the CS voice mailbox into IP voice packets, and sends the IP voice packets to the Internet Host IH. It will be recognized from the procedures at 81 and 83 that the GPMSC 32 operates in FIGURE 8 as a conventional IP Voice Gateway. If the call is not finished at 85, then the procedure

returns to re-enter block 81. If the call is finished at 85, then the procedure moves to point A in FIGURE 4 to re-enter decision block 21 of FIGURE 4.

FIGURE 9 illustrates another example response of the GPMSC 32 when the mobile subscriber unit is busy at 23 in FIGURE 4 or the mobile subscriber unit does not accept the IP voice call at 53 in FIGURE 5. The procedure of FIGURE 9 is designated at E in FIGURES 4, 5 and 9. In FIGURE 9, the GPMSC 32 sets up and conducts an IP voice session between the Internet Host IH and the GPMSC, and also sets up and conducts a CS voice session between the GPMSC and a conventional telephone number (see FIGURE 3). The procedures at 91 and 93 in FIGURE 9 are analogous to the procedures at 81 and 83 in FIGURE 8, the CS voice session in FIGURE 9 being conducted between the GPMSC and the telephone number rather than between the GPMSC and the CS voice mailbox as in FIGURE 8. The communication link 39 between GPMSC 32 and the telephone number can include, for example, a PSTN or ISDN network or a radio network (see FIGURE 1).

FIGURE 10 illustrates an example of the response of the GPMSC 32 when the mobile subscriber unit accepts the IP voice call but chooses the CS mode in FIGURE 5. The procedure in FIGURE 10 is designated at G in FIGURES 5 and 10. In FIGURE 10, the GPMSC sets up and conducts an IP voice session between the Internet Host IH and the GPMSC, and also sets up and conducts a CS voice session between the GPMSC and the mobile subscriber unit MS. The procedures indicated at 101 and 103 in FIGURE 10 are analogous to those indicated at 81 and 83 in FIGURE 8 and those indicated at 91 and 93 in FIGURE 9, the CS voice session in FIGURE 10 being conducted between the GPMSC and the mobile subscriber unit MS.

It will thus be appreciated that the GPMSC 32 acts in FIGURE 8 as a conventional IP Voice Gateway between the Internet Host IH and the CS voice mailbox, and acts in FIGURE 9 as a conventional IP Voice Gateway between the Internet Host IH and the telephone number, and acts in FIGURE 10 as a conventional IP Voice Gateway between the Internet Host IH and the mobile subscriber unit MS/DTE.

According to the foregoing description, an IP voice call received from Internet Host IH and directed to the mobile subscriber unit MS and data terminal equipment DTE at MS/DTE can be redirected to an IP Voice Mailbox (FIGURE 6) or to another

Internet Host IH1 (FIGURE 7). Further, the GPMSC can be operated as an IP Voice Gateway between the Internet Host IH and a circuit-switched voice mailbox (FIGURE 8) or between the Internet Host IH and a telephone number (FIGURE 9). In each of FIGURES 6-9, the information in an IP voice call directed to the mobile subscriber unit is redirected or forwarded instead to a destination other than the mobile subscriber unit. These redirecting operations of FIGURES 6-9 may be employed when the mobile subscriber unit is busy at 23 in FIGURE 4 or when the mobile subscriber unit does not accept the IP voice call at 53 in FIGURE 5.

If the call waiting procedure of FIGURE 5 is executed after determining that the mobile station is busy at 23 in FIGURE 4, then any of the operations of FIGURES 6-9 may be selected if the mobile subscriber unit does not accept the IP voice call at 53. If the IP voice call is accepted at 53, and if the mobile subscriber unit chooses the circuit-switched mode, then the GPMSC 32 acts as an IP Voice Gateway between the Internet Host IH and the mobile subscriber unit MS/DTE as illustrated in FIGURE 10. If the IP voice call is accepted for packet mode delivery at 55, then a conventional IP voice session is set up and conducted between IH and MS/DTE.

The present invention thus provides for processing a packet-switched voice call when the mobile subscriber unit is busy in a circuit-switched voice call, and does not require rejection of the packet-switched voice call.

All IP voice sessions described above are set up using well-known conventional techniques such as described in ITU-T (Telecommunication Standardization Sector of the International Telecommunication Union) Recommendation H.323 (11/96), which is hereby incorporated herein by reference. All CS voice sessions described above are readily set up using well-known conventional telephony techniques such as promulgated by ITU-T.

It will be evident to workers in the art that GPMSC 32 of FIGURES 3-10 can, in one example approach, be readily realized by appropriately modifying the software in the conventional GPMSC of FIGURES 1-2. Other suitable combinations of hardware and software modifications in the conventional GPMSC will also suffice to realize GPMSC 32, as will be evident to workers in the art in view of the foregoing description.

Although exemplary embodiments of the present invention have been described above in detail, this does not limit the scope of the invention, which can be practiced in a variety of embodiments.

WHAT IS CLAIMED IS:

1. A method of processing a packet-switched voice call directed to a mobile subscriber unit in a cellular communication network, comprising:

determining that the mobile subscriber unit is in a circuit-switched mode of operation; and

forwarding the information in the packet-switched voice call to a destination other than the mobile subscriber unit.

2. The method of Claim 1, wherein said forwarding step includes forwarding the packet-switched voice call to a packet-switched voice mailbox.

3. The method of Claim 1, wherein said forwarding step includes forwarding the information in the packet-switched voice call to a circuit-switched voice mailbox.

4. The method of Claim 1, wherein said forwarding step includes forwarding the packet-switched voice call to an Internet Host.

5. The method of Claim 1, wherein said forwarding step includes forwarding the information in the packet-switched voice call to a telephone number.

6. The method of Claim 1, wherein said forwarding step includes conducting a packet-switched voice session between a source of the packet-switched voice call and a GPMSC, and conducting a circuit-switched voice session between the GPMSC and the destination.

7. The method of Claim 6, wherein said last-mentioned conducting step includes using the GPMSC to convert the packet-switched voice call into a circuit-switched voice call.

8. The method of Claim 7, wherein the destination is a circuit-switched voice mailbox.

9. The method of Claim 7, wherein the destination is a telephone number.

10. The method of Claim 7, wherein the source is an Internet Host.

11. The method of Claim 1, wherein said forwarding step includes conducting a packet-switched voice session between a source of the packet-switched voice call and the destination.

12. The method of Claim 11, wherein said conducting step includes changing a destination address of a voice packet that is enroute from the source to the destination.

13. The method of Claim 11, wherein said conducting step includes changing a source address of a voice packet that is enroute from the source to the destination.

14. The method of Claim 13, wherein said conducting step includes changing a destination address of a voice packet that is enroute from the source to the destination.

15. The method of Claim 14, wherein said changing steps include using a GPMSC to change the addresses.

16. The method of Claim 15, wherein the source is an Internet Host.

17. The method of Claim 16, wherein the destination is a packet-switched voice mailbox.

18. The method of Claim 16, wherein the destination is a further Internet Host.

19. The method of Claim 11, wherein said conducting step includes changing a destination address of a voice packet that is enroute from the destination to the source.

20. The method of Claim 11, wherein said conducting step includes changing a source address of a voice packet that is enroute from the destination to the source.

21. The method of Claim 20, wherein said conducting step includes changing a destination address of a voice packet that is enroute from the destination to the source.

22. The method of Claim 21, wherein said changing steps include using a GPMSC to change the addresses.

23. The method of Claim 22, wherein the source is an Internet Host.

24. The method of Claim 23, wherein the destination is a packet-switched voice mailbox.

25. The method of Claim 23, wherein the destination is a further Internet Host.

26. A method of processing a packet-switched voice call directed to a mobile subscriber unit in a cellular communication network, comprising:

determining that the mobile subscriber unit is in a circuit-switched mode of operation; and

notifying the mobile subscriber unit of the packet-switched voice call.

27. The method of Claim 26, including determining that the mobile subscriber unit has accepted the packet-switched voice call, and thereafter conducting

a packet-switched voice session between the mobile subscriber unit and a source of the packet-switched voice call.

28. The method of Claim 26, including determining that the mobile subscriber unit has accepted the packet-switched voice call, and thereafter converting the packet-switched voice call into a circuit-switched voice call to the mobile subscriber unit.

29. The method of Claim 28, wherein said converting step includes receiving voice packets at a GPMSC, and outputting from the GPMSC the circuit-switched voice call to the mobile subscriber unit.

30. The method of Claim 26, including determining that the mobile subscriber unit has rejected the packet-switched voice call, and thereafter forwarding the information in the packet-switched voice call to a destination other than the mobile subscriber unit.

31. The method of Claim 30, wherein said forwarding step includes forwarding the packet-switched voice call to a packet-switched voice mailbox.

32. The method of Claim 30, wherein said forwarding step includes forwarding the information in the packet-switched voice call to a circuit-switched voice mailbox.

33. The method of Claim 30, wherein said forwarding step includes forwarding the packet-switched voice call to an Internet Host.

34. The method of Claim 30, wherein said forwarding step includes forwarding the information in the packet-switched voice call to a telephone number.

35. The method of Claim 1, wherein the packet-switched voice call is an IP voice call.

36. The method of Claim 26, wherein the packet-switched voice call is an IP voice call.

37. A switching apparatus for processing information in a packet-switched voice call directed to a mobile subscriber unit of a cellular communication network, comprising:

an input for receiving the packet-switched voice call;

a further input for receiving information indicative of whether the mobile subscriber unit is busy in a circuit-switched voice call; and

an output through which the information in the packet-switched voice call is forwarded to a destination other than the mobile subscriber unit if the mobile subscriber unit is busy in a circuit-switched voice call.

38. The apparatus of Claim 37, wherein the packet-switched voice call is an IP voice call.

39. A switching apparatus for processing information in a packet-switched voice call directed to a mobile subscriber unit of a cellular communication network, comprising:

an input for receiving the packet-switched voice call;

a further input for receiving information indicative of whether the mobile subscriber unit is busy in a circuit-switched voice call; and

an output through which the mobile subscriber unit is notified that the packet-switched voice call is waiting if the mobile subscriber unit is busy in a circuit-switched voice call.

40. The apparatus of Claim 39, wherein the packet-switched voice call is an IP voice call.

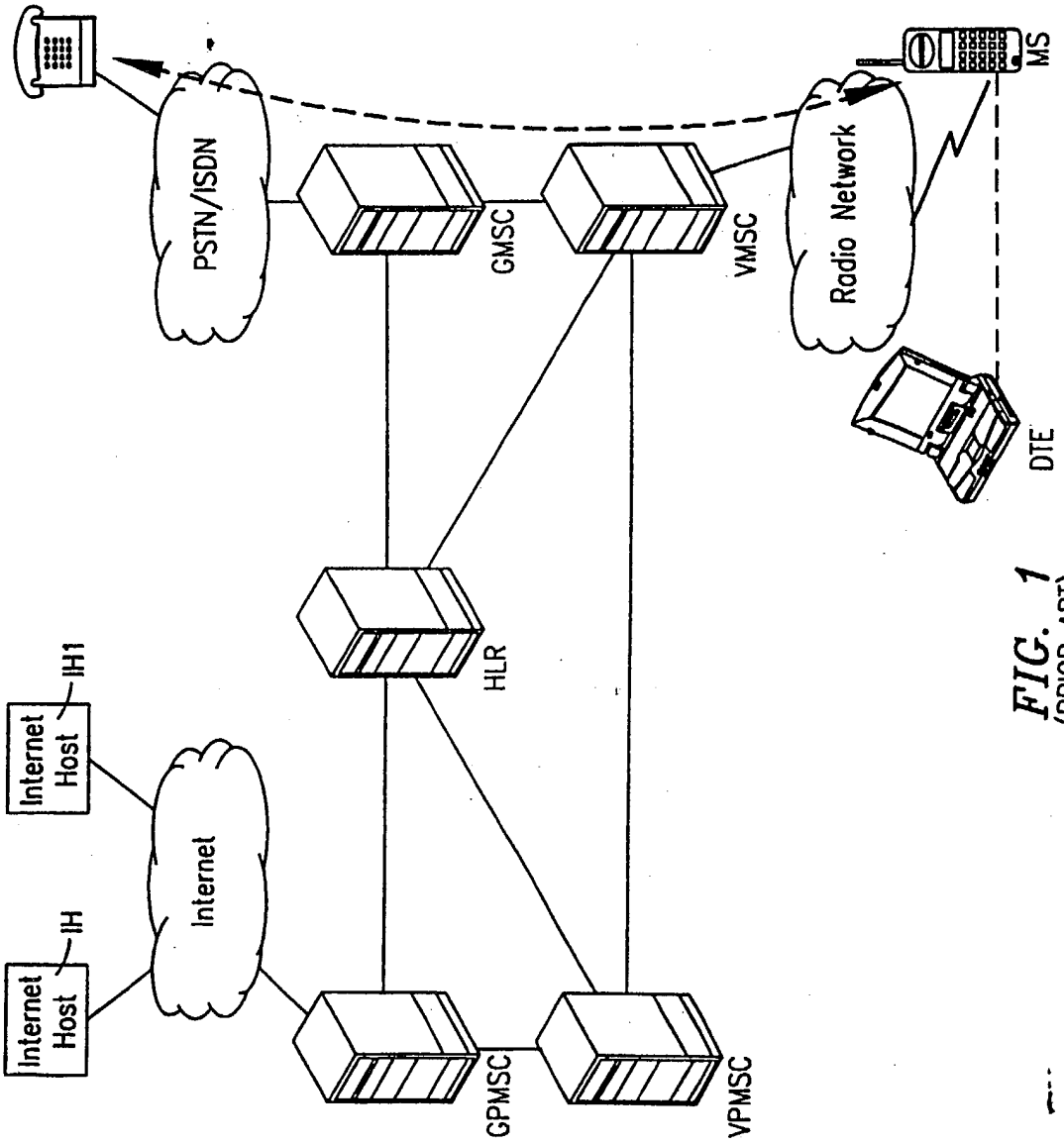

FIG. 1
(PRIOR ART)

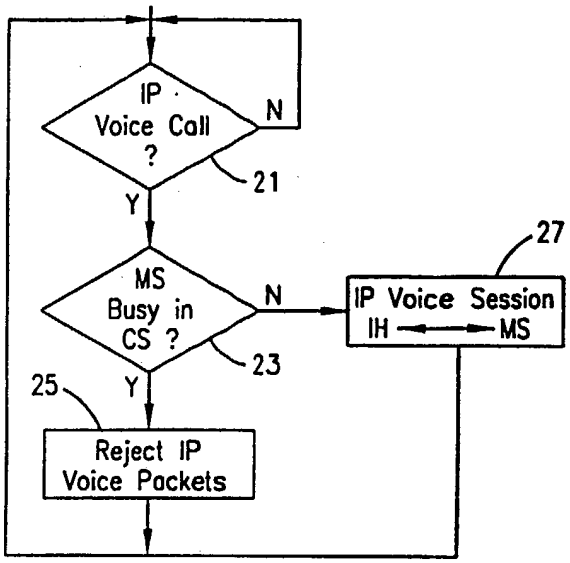

FIG. 2
(PRIOR ART)

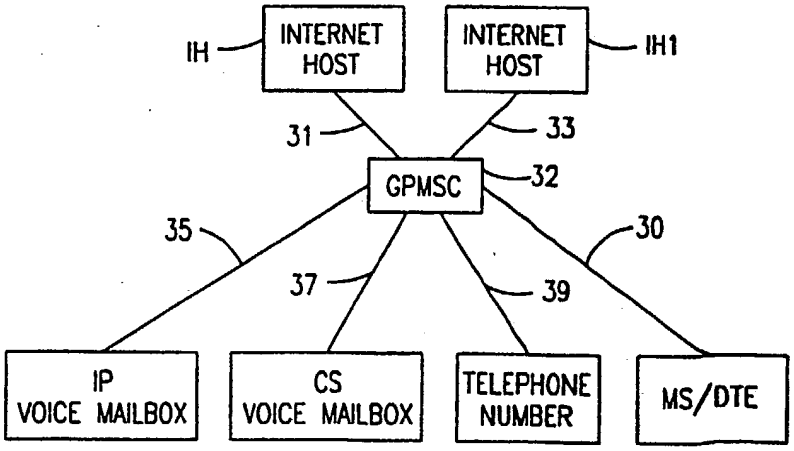

FIG. 3

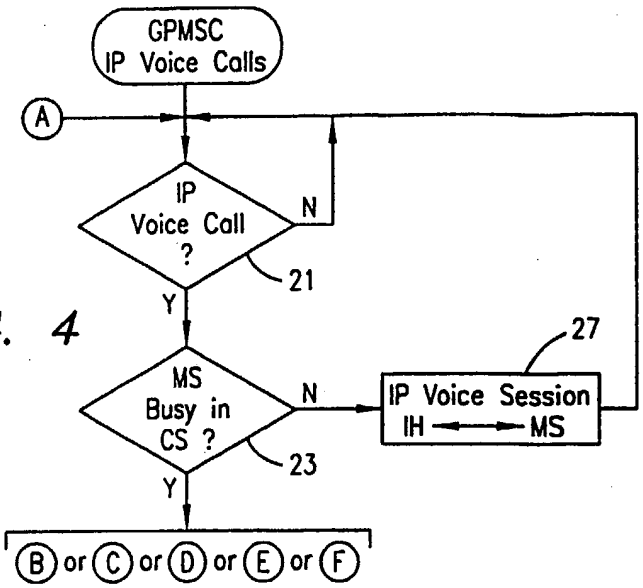
GPMSC
IP Voice Calls
A
IP
Voice Call
?
N
21
Y
MS
Busy in
CS ?
N
23
Y
27
IP Voice Session
IH ⟷ MS
B or C or D or E or F

FIG. 4

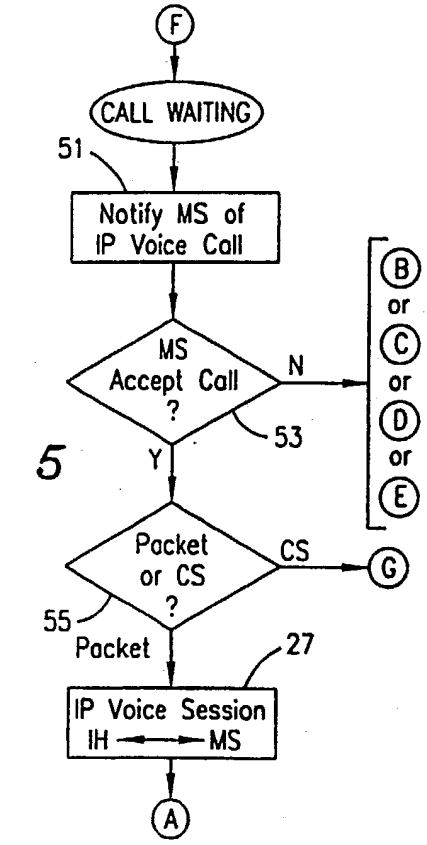
F
CALL WAITING
51
Notify MS of
IP Voice Call
MS
Accept Call
?
N
53
Y
B
or
C
or
D
or
E
Packet
or CS
?
CS
G
55
Packet
27
IP Voice Session
IH ⟷ MS
A

FIG. 5

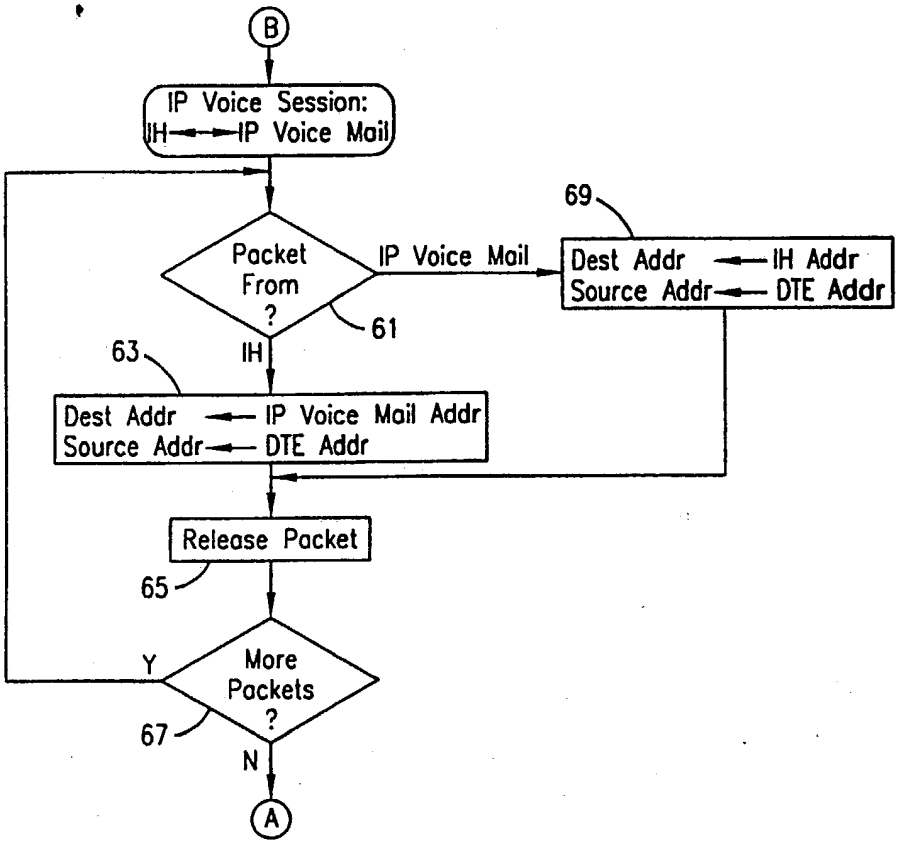
B
IP Voice Session:
IH ←→ IP Voice Mail
Packet From ?
61
IP Voice Mail
69
Dest Addr ← IH Addr
Source Addr ← DTE Addr
IH
63
Dest Addr ← IP Voice Mail Addr
Source Addr ← DTE Addr
Release Packet
65
More Packets ?
67
Y
N
A

FIG. 6

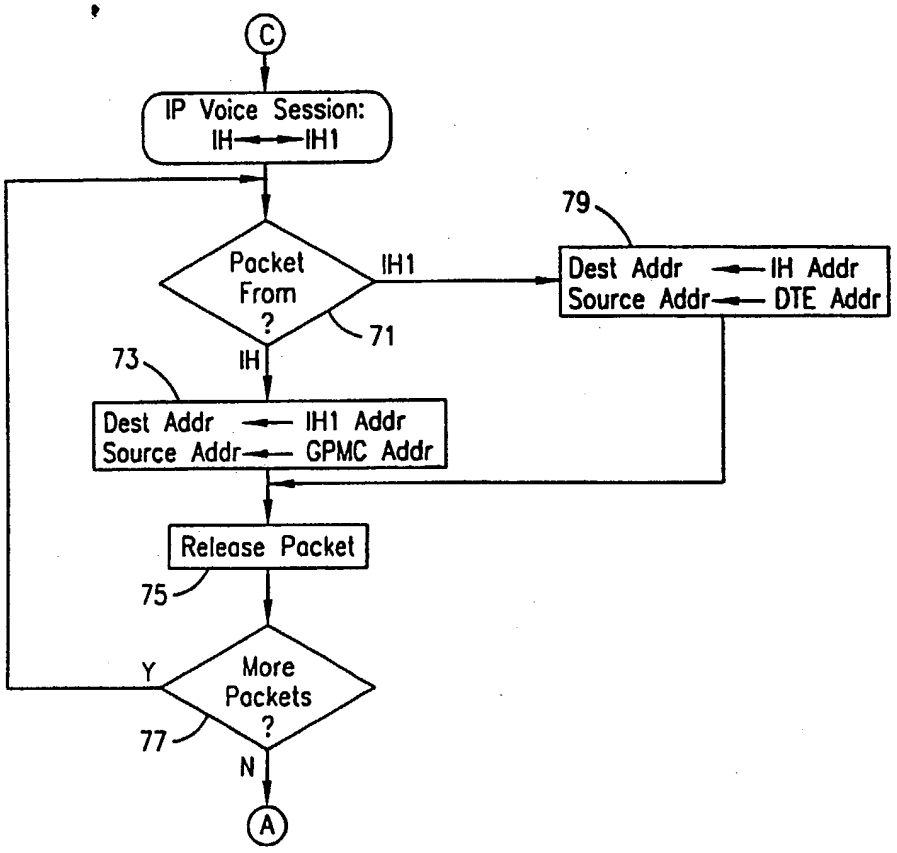
C
IP Voice Session:
IH←→IH1
Packet From ?
IH1
IH
71
79
Dest Addr ← IH Addr
Source Addr ← DTE Addr
73
Dest Addr ← IH1 Addr
Source Addr ← GPMC Addr
Release Packet
75
More Packets ?
Y
77
N
A

FIG. 7

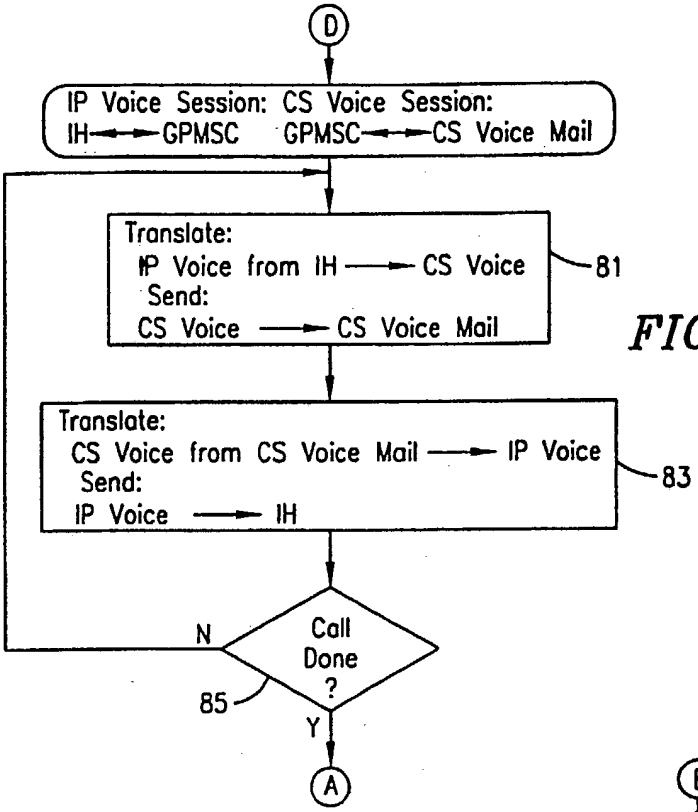
D
IP Voice Session: CS Voice Session:
IH GPMSC GPMSC CS Voice Mail
Translate:
IP Voice from IH CS Voice
Send:
CS Voice CS Voice Mail
81
Translate:
CS Voice from CS Voice Mail IP Voice
Send:
IP Voice IH
83
Call Done ?
N
Y
85
A

FIG. 8

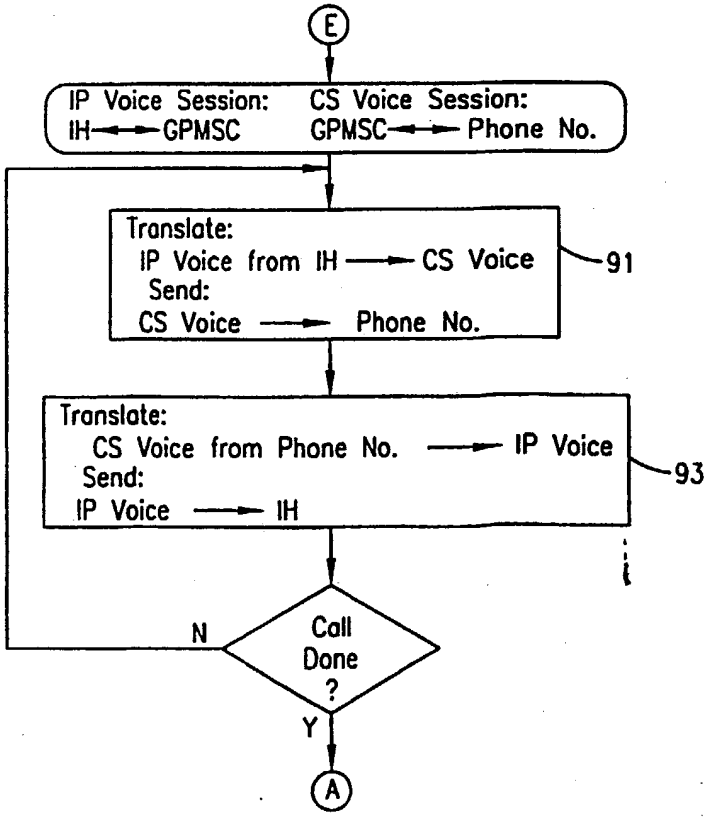
E
IP Voice Session: CS Voice Session:
IH GPMSC GPMSC Phone No.
Translate:
IP Voice from IH CS Voice
Send:
CS Voice Phone No.
91
Translate:
CS Voice from Phone No. IP Voice
Send:
IP Voice IH
93
Call Done ?
N
Y
A

FIG. 9

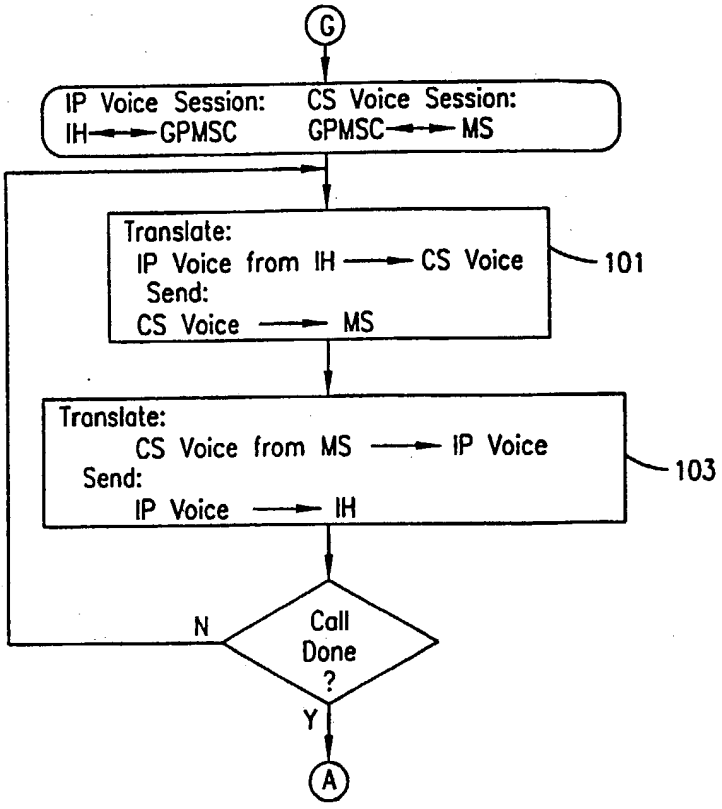
G
IP Voice Session: IH ⟷ GPMSC
CS Voice Session: GPMSC ⟷ MS
Translate: IP Voice from IH → CS Voice
Send: CS Voice → MS
101
Translate: CS Voice from MS → IP Voice
Send: IP Voice → IH
103
Call Done ?
N
Y
A

FIG. 10

INTERNATIONAL SEARCH REPORT

Interr nal Application No
PC1/SE 99/00185

A. CLASSIFICATION OF SUBJECT MATTER
IPC 6 H04M7/00 H04Q7/22

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 6 H04M H04Q H04L

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	EP 0 758 175 A (NIPPON TELEGRAPH & TELEPHONE) 12 February 1997 see abstract see page 14, column 25, line 10 - page 15, column 28, line 56 see figure 13	1,2,26, 30,31, 37,39
A	US H1641 H (SHARMAN DUANE R) 1 April 1997 see the whole document	1-40
A	US 5 327 486 A (KRAMER MICHAEL ET AL) 5 July 1994 see abstract see figures 2,3	1-40

-/--

[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

° Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

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"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

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"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
7 June 1999	16/06/1999

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+31-70) 340-3016	Megalou, M

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INTERNATIONAL SEARCH REPORT

Inter. ...nal Application No
PC.../SE 99/00185

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

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A	WO 97 26764 A (NOKIA TELECOMMUNICATIONS OY ;KARI HANNU H (FI); HUOTARI SEPPO (FI)) 24 July 1997 see page 14, line 6 - page 15, line 15 ---	1-40
A	EP 0 750 439 A (NIPPON TELEGRAPH & TELEPHONE) 27 December 1996 see the whole document -----	1-40

INTERNATIONAL SEARCH REPORT

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Interi ...nal Application No
PCT/SE 99/00185

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